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DESIGN AND DEVELOPMENT OF AN EXPERIMENTAL LOW-COST INTERNET-BASED INTERACTIVE TV STATION

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Abstract

Internet-based interactive TV is an emerging field that is affected by advances in various research areas including communication, interactivity, network efficiency, content management and aesthetics. Despite constantly reducing costs in the area of broadcast infrastructure development, this new medium has yet to claim its market position and recognition. Various reasons may be identified for this lack of penetration in today's markets. The large market-share of existing non-interactive technologies is a governing factor, followed by quality of service issues and the absence of a widely accepted standard for interactive broadcasting that will enable the development of devices that allow interaction in an out-of-the-box user-experience.

Various independently developed software-based technologies such as Joost, Babelgum and VeohTV have explored to certain extent the interactive and social aspects of streaming media, including live user-to-user chat, dynamic content search and the formation of user-groups. On the experimental forefront, various educational institutions are exploring continuously the capabilities of high-bandwidth networks and experimental interactive content in order to set the standards for new digital services, transforming the two-way broadcasting experience. For particular types of content such as interactive installation art, games and multimedia presentations that require synchronised content to be communicated, such technological infrastructures offer an alternative method of deployment, presentation and interaction.

In this work, we are mainly concerned with the development strategy of the interactive TV system, the integration of existing technologies under a common environment, user-related usability issues and aesthetics, all being factors that affect the cost of interactive TV. We present the design and issues that arise and discuss the development issues that affect the end-user experience, while the cost minimised due to the use of open-source technologies.

Keywords: Interaction, Multimedia, Communication, Design, Aesthetics, Meta-data

1   INTRODUCTION

When the first television sets were introduced to the public, they were advertised as a "Radio with a Screen". The advertisement stated that the listener would be able to simultaneously listen and view the musicians performing. A few years later, the technologically identical medium was actively used for many "novel" purposes including the transmission of educational, recreational and plethora of other types of broadcasts.

Similarly today, interactive Internet broadcasting is often referred to as Internet TV, ignoring in the majority of cases all the new social and educational aspects that interactivity and virtual communication technologies have to offer through this new medium. In fact, interactive television technologies such as dynamic video, computer-based exploratory content and advanced interaction technologies have already been employed in various fields of the information society furnishing or supporting entirely

educational, commercial and research applications (Jaimes & Sebe, 2007). Under this context, one may safely assume that existing interactive technologies and techniques may be employed under interactive broadcasting in order to cover multiple user-requirements, while supporting dynamic interaction throughout (Deliyannis, 2007).

The underlying supporting technologies for Interactive Internet broadcasting are still not fully established, a fact that affects the influence of this new medium. During the last decade the users experienced rapid changes in the standards and formats of interactive broadcasting. Initial research on autonomous interactive applications (Constantine Stephanidis & Akoumianakis, 2001; Helena & Jorge, 2001; Julio Abascal, Ant, & n, 2001) were followed by the development of hybrid systems that multiplex various existing standards and formats in order to successfully complete the task in hand across multiple software/hardware platforms and network configurations (Deliyannis, 2006; Martin, 2005; Webster, 2004).

Various factors affect the deployment of these technologies. Established terrestrial and satellite broadcasting networks are armed with strategic agreements with content providers, attracting the main volume of viewers. In that respect, the content in most cases dictates whether a system will be selected or not by the viewers. Similarly in the past one may contrast and analyse the battle between BETA and VHS technologies, or recently the HD-DVD and BLUE-RAY-DVD where in both cases the availability of content won the battle of the formats, as customers preferred one device instead of the other.

Non-use non-adoption is a common phenomenon of the information society that also affects the deployment of interactive internet-based TV (Webster, 2004). Typically, users are not willing to pay for services that they already receive for free or at a minimal cost from other providers. The same applies when they are asked to replace their equipment with new devices. The cost affects also the developers as the cost of propriety coders and decoders has forced many to choose or develop open transmission protocols that are freely distributable. The above factors result in a one-way route for internet-based interactive TV developers who are forced to deploy open systems that support free player technologies in an attempt to attract a large user-base. In that respect, their supporting income is sourced from advertising and other means of promotion, which again is proportional to their user base.

On the positive side, the decreasing Internet connection costs and the increasing access speeds offered shape the market for new interactive internet-based broadcasting services. With a dedicated internet-connection, one may receive at home high-quality TV programmes, at a fraction of the cost of satellite TV. The authors believe that this is a quite significant development that allows new services to be introduced without the impracticality to replace existing viewing equipment. Understanding of the user needs and refinement of the broadcasting requirements is essential for the developers. This paper presents and discusses the experience gained in the development of an experimental interactive broadcasting station, which features several feedback options and was designed to cover the needs of users in terms of quality, aesthetics, functionality, accessibility, interaction and feedback.

2   USER REQUIREMENTS AND INTERACTION DESIGN

The main purpose of the web-based interactive broadcasting station is to promote artistic student work (Lovejoy, 2004) designed and developed in the Department of Audio and Visual Arts, Ionian University, Corfu, Greece. A secondary function involves presentation of the wide variety of events organised by the department such as talks, seminars, conferences, concerts and field trips. Archiving of this information is essential for future reference. Finally, the need for digital presence is important for the department of Audiovisual Arts, as it enables student-artists to expose their work without boundaries and cost constraints, through a globally accessible medium that permits user-to-user communication. Various interaction design issues are discussed below, describing how developers with network and cost constraints may utilise external services in order to cover particular user requirements while minimising the network and cost effects.

2.1 From user interaction requirements to system specification design

User requirements play a significant role in the design process, as this case study revealed a number of conditions of particular interest to the artists that needed to be met by the system. For example, it is essential for the broadcasting platform to accurately present video and audio information, in order to match the intended quality of the original video creations, a fact that forced the development team to evaluate the colour output and compression loss across a wide variety of signal coders/decoders.

Initial content analysis showed that most of the submitted works are created or recorded in DV and DV-wide formats, thus support for high-definition information was not critical at this stage, yet the system should be able to support this new standard should the need arise.

Interaction requirements are examined for various use scenarios. First, the ability to access directly and choose the order of presentation of archived content is covered throughout with direct and dynamic linking to the archive. Metadata information may be added in two stages: stream version, total playing time, preview icon, stream-type and user-information is added automatically at the moment the stream is uploaded to the server, followed by keywords and links to other content that may be added at later time. This organisation follows propriety standards, enabling the reduction of the cost of multimedia stream archiving that is a common problem for most low-budget broadcasting services. Essentially what is actually suggested is the use of existing systems in order to store the streams. Characteristic candidate systems today may include the "Google Video" and "YouTube HD" services, enabling direct user linking and external access at no cost, while it enables the video component to be consistent with the MPEG-7 standard, as this information is stored both within the target video-server system and separately in XML format under the station website. The main difference observed when comparing the currently developing system with other propriety video on demand systems is the fact that they do not support live event broadcasting, and most importantly, the choice between different perspectives and camera views. In that respect, interactive stream selection is a novel dynamic function designed to be supported by the system. Various in-house events recorded with multiple cameras may be accessed independently, offering the user interactive viewpoint selection. The system is designed to offer additionally the edited version that is mixed at the studio by the console operator and the director.

Interactive user feedback is supported through the portal. An RSS feed is employed to provide user commenting and dialogue, after registration and user verification, enabling text information to be communicated directly to the programme producers and the participating members. User feedback is also supported in video format, provided they are able to record their views and publish them into a supported format and service that may be externally linked to the feed.

From the software-engineering perspective the spiral model was employed during system development. This allows the system to evolve and grow based on user and developer feedback, while it enables the addition of new functionality at later stages, as it is based on open source code.

2.2 Development through open-source code

All the above requirements do not pose significant developmental difficulties, as they utilise existing web technologies that require little or no programming and may be deployed in a wide variety of platforms (Diomidis Spinellis & Szyperski, 2004). Propriety or open-source code is provided for all the above uses, from the development of a complete "station portal" to the broadcasting method itself. The use of CMS technologies such as "Joomla!" and "Drupal" allow the deployment of a fully customisable interface complete with RSS feeds, support for the submission, editing and publication of online articles and supporting to the video-works stories, discussion areas with registered users and moderators, audiovisual galleries, support for various administrative roles with variable access privileges and the ability to develop customised templates. Current system development utilises a Joomla! version, while the video database is held under PHPmotion, a free media-sharing CMS.

Most of the programming effort has to be spent on the design of the user interface with particular reference to its usability and aesthetics, as existing technologies do not always share the same interface standards, a fact that requires end-system template modification. Developers have therefore to be in a position to alter the look and feel of each individual component, resulting in a unified interactive environment, which covers the functional needs of both the user and the programme producer. For the current case study in particular, one may the summarised technologies and platform choices under Table 1 where the developmental flexibility is clearly evident.

REQUIREMENT	STANDARD	SUPPORTING PLATFORM
1 Website	html, css	
2 Archived Video Stream	unicast, multicast, mpeg4	
3 Live Video Streams	multicast	
4 Interactive Video Streams	multiple multicast servers, html, player	windows, osx, linux
2 Interactive User Feedback	html, rss	
2 Video User Feedback	DV standard, external service, html linking	

Table 26.   Station requirements, standards and platforms supporting these technologies

3   CONTENT, CONTEXT AND USER INTERFACE

Typical television stations base their functionality on programming. The viewer is informed by a timetable separated in programme zones for each day about the availability of each video stream. For example the daily news programme always begins and ends at specific times usually presenting sports and weather reports during its end. This is clearly inefficient, particularly when two internet-based users want to view the latest news, as the system has to calculate their local time and adjust accordingly the timetable. With interactive broadcasting the queued time-limitations are no longer present, as the user is allowed to search and select the content to be viewed, without expecting the previous programme to be broadcasted completely. It should be possible therefore for a user that is only interested in the weather to view the latest report on demand, or even watch the weather prediction for a specific area of the country. This major ability is mainly responsible for the differentiation between digital or web-TV to dynamic interactive TV, and the only practical requirement is to provide metadata information regarding the information contained within the stream and its timing (Caschera, Ferri, & Grifoni, 2007).

3.1   Interactivity

The novelty of the current case study focuses mainly on the lack of content pre-programming. We focused on the essence of MPEG-7 in terms of content representation in our implementation, particularly as it was necessary to furnish the user with the flexibility to navigate semantically across the content. A typical example would include searching of semantically related works between different artists, in an attempt to artistically and emotionally describe with the use of video art selected notions such as "love" and "happiness" (Hansen, 2004). Another use may be the evaluation of the progress of a student-artist by viewing the published works in chronological order.

In order to achieve this functionality descriptors are entered in a descriptor scheme (Caschera, et al., 2007), forming an informal yet dynamic description definition language, as it is user-defined. Artist that upload a new video to the system are allowed to set the descriptors and the descriptor scheme of their choice. Other artists may choose to employ the schemes and descriptors already entered in the system, through drop-down menus, or create their own. In this respect we allow each creator to express their views and describe their content using their own customised expressions, which may not fall under an existing language vocabulary. There are instances for example that words such as "woooooosh" and "ouch" are utilised to describe sounds within uploaded movies that alternatively would need to be described using many more descriptive words (K. Sivashanmugam, 2003; Nack & Hardman, 2002). Once entered into the system these are stored under the underlying XML description scheme. Note here

that although we focus on accurate representation, the solution is to allow each creator to create their own vocabulary, a fact that allows semantic links to be made across the majority of terms. As this implementation is quite new, it is necessary to mature in order to evaluate its performance in the long term.

3.2   User Interface Design

When examining the organisation from top to bottom, one is introduced to the central menu of the interactive station. The web address registered (imediatv.eu) that displays the latest system version, clearly defines the objective of the service, while the logo is self-informative. The options offered at this stage are shown in Figure 1: "Interactive TV", "News in Text", "Programme", "Video Archive", "User Settings", "Submit your Content", "BackOffice Access", "Contact Us".

Figure 1.   Central menu choices of the internet-based interactive TV service, enabling information and interactive access to all features to the user over the web interface, through a unified web-based CSS animated menu.

User interface design is based on the user requirements analysis. This indicated that although interaction is the main programme driver, a user transcending from traditional TV medium to Interactive TV would find this experience increasingly demanding, a major factor of non-use non-adoption phenomenon. As a result, a principal design choice introduced is the provision of the default user with a pre-determined programme, displayed under the "Programme" option, that automatically displays the chronologically newest stream that is added to the system, while at every stage the user is presented with the option to select an alternative stream via keyword (content-context) selection. Upon selection of the "Interactive TV" option the player initiates and a supporting window is displayed offering additional information about the stream displayed together with the related keywords.

4   CONCLUSION

We have presented a series of issues that arise when developing an experimental web-based interactive TV service. This system has been constructed using existing individual components and technologies, open source systems and portals. From the computer science perspective, the system is designed to be customisable, platform independent and expandable, while a common XML-based database of content is used to synchronise and relate between the applications. New services may be easily implemented, enriching the end-system functionality. Of great interest is the methodology employed to interact with content, enabling the same system to simultaneously accommodate two use types: users may choose to watch the programme without interaction, while at any stage they are able to link to other content of interest with a selection of a keyword or a search string. Integrated media access, user participation, a

uniform user-interface, dynamic content-access and open standards summarise the main factors that render such systems competitive and cost effective.

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