The Virtual Channel Model for Personalized Television

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Abstract

This research* is based on the realization that the desktop computing paradigm is not appropriate for television, because it is adapted to fundamentally different user aspirations and activities. Instead, the virtual channel is proposed as a model that explains the proper design of user access to personalized television programming. The virtual channel is a model that aids the organization and dynamic presentation of television programming from a combination of live broadcasts, prerecorded content and Internet resources at each set-top box. In this paper, we describe two applications that have been used to validate the virtual channel model. We have employed the properties of the virtual channel model into the design of personalized television advertising and interactive music video clip programming. Finally, we describe an ActiveX control that implements a core set of the virtual channel's features.

Keywords

Interactive Television, Usability, Design Model, Personalization, Music Video Clips, Advertising, User Model

The Need for an Alternative Computing Paradigm

Authorities have been talking long before the necessary technology becomes available about a shift in the way TV programs are going to be delivered. Nicholas Negroponte (1995) said that: 'TV benefits most from thinking of it in terms of bits. Once in the machine, there is no need to view them in the order they were sent,' implying that some kind of logic —either user choice or from some other source— could be applied on the TV content. Then he goes on to forecast with accuracy the ability to time-shift television programming: 'All of a sudden TV becomes a random access medium, more like a book or newspaper, browsable and changeable, no longer dependent on the time or day, or time required for delivery.'

Nowadays, there is growing evidence from the marketplace that information technology is migrating from the PC in the office to the set-top box in the living room (Wallich 2002). The set-top box (STB) category encompasses devices that range from MP3 juke boxes (HP dec100), digital satellite receivers (Nokia Mediamaster), digital video recorders (TiVo, ReplayTV), as far as combinations of the above (Digeo Moxi Media Center). User access to the STB is usually done according to the manufacturer's idiosyncrasy or by applying rules from the desktop experience (Carey 1997).

Most notable among the recent findings about the STB class of devices is the realization that users' subjective satisfaction is at odds with performance metrics. In a usability test of three video skipping interfaces (two commercial and one novel), users preferred the interface that required more time, more clicks and had the highest error rate. According to Drucker et al. (2002) 'While the performance based on time to task completion and number of clicks was the worst in the novel interface, the user satisfaction was significantly better with this interface.' Users reasoned their choice on the basis of how fun and relaxing an interface was.

Since traditional human-computer interaction (HCI) settings involve a task-oriented approach where the

* Parts of this work were supported by the IMEDIA (IST-1999-11038), CONTESSA (IST-2000-28567) and MUSICAL (EDC-22131) projects, partially funded by the European Commission.

human interacts with an application to accomplish a particular goal, computer-mediated leisure applications require a fresh view of the current paradigms.

The need for alternatives to the desktop paradigm has been described before from Aaron Marcus: 'in the coming decades, not only workstations, but playstations, appliances are likely to contain embedded microprocessors' (Marcus 1993), 'I do not foresee future interfaces devoid of metaphors' (Marcus 2002). Strong evidence of the importance of a metaphor for the case of the STB is provided by O'Brien et al. (1999), in an ethnographic study of a digital set-top box trial, in which they point out the need for a 'working model' of the technology being employed by users in home activities.

The Virtual Channel Model

The ubiquity of broadcast transmissions has established a universal method for access to media programming. The television and radio channel is a familiar concept for providing easy access to audiovisual content across all user groups. By exploiting the ubiquity and familiarity of the broadcasting mentality, we propose the virtual channel model for access to digital media content. In our view, neither the vision of five hundreds channels, nor the vision of a single personalized channel is suitable. A small number of personalized virtual channels offers enough choices to cater for serendipity in media experiences, while simplifying the choice from vast and diversified sources of media content.

Traditional television experience consists of two layers: 1) the background is reserved for video play-out, while 2) the foreground is used to display overlaid information, either relevant to the background programming or time critical data. However, both layers are created and controlled at the media source. The core idea behind the virtual channel proposition, as depicted in Figure 1, is that the decision-making about media programming has shifted from the media source to the STB. The television experience is now created and controlled at the STB from a combination of local storage, real time broadcast transmissions and Internet resources.

The STB can be imagined as a virtual channel provider, where the television experience is produced from a combination of local storage, real time broadcast transmissions and Internet resources of services, audiovisuals and textual data.

The organization of media content into a small number of personalized virtual channels simplifies the choice from a vast array of available broadcasts, stored content and Internet resources. The presentation of media programming from virtual channels gives more control to the user, who becomes an important factor in the televised content. The virtual channel model suggests only a minimal shift from the current patterns of television use (Lee & Lee 1995), while it focuses further research on the design of a user interface for creating and managing virtual channels.

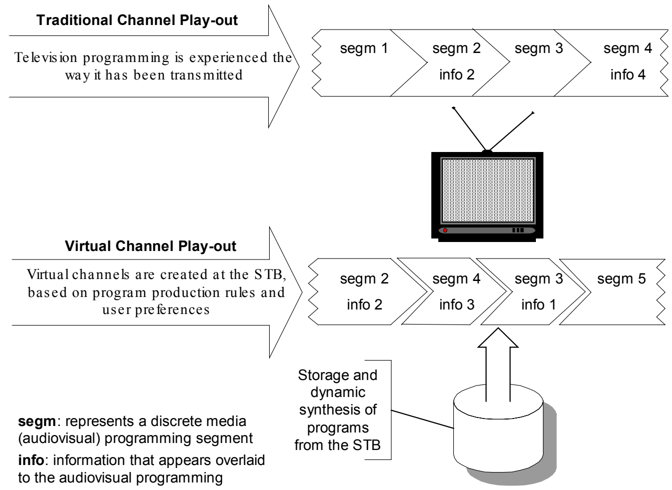

Figure 1 Generic model of a system employing the virtual channel model, in contrast with traditional broadcasting

Previous Research and Framework of Contribution

Firstly and foremost, the virtual channel is a model that was inspired after the experience of working with the broadcasting and advertising industry*. In our view, the virtual channel model represents a feasible and effective synergy between two radically different mentalities; those of broadcasting and information technology. The virtual channel model allows broadcasters to exploit their current strengths within digital technologies in a comprehensive way. At the same time, information technology developers benefit from a clear, although different to theirs, vision for designing suitable interactive television applications.

Furthermore, the virtual channel is an implementation of an ActiveX control (a popular type of reusable software component used in Microsoft Windows) that can be used for rapid prototyping of interactive television applications. Both broadcasters and developers can use the continuously expanding library of the virtual channel properties, methods and events to design prototypes of interactive television applications. In this paper, we are also giving an example of

* After collaborating with broadcasters —RAI Research (IT), Canal+ (BE), Danmarks Radio (DK), ERT (GR)— for some time, we have come too, to recognize the necessary and mutual relationship with the advertising industry, which is the primary financial supporter of media programming.

developing a simple interactive television application for music video clips that features dynamic ad breaks and a presentation agent.

The virtual channel model originates from the successful contemporary interactive television designs, like ‘personalized news ticker’, ‘interactive game’, or ‘now plays’ information. Information overlays have been a popular and appropriate way to enhance television watching without disturbing the established patterns of television use. The virtual channel is a model that shows a clear path towards the design of future interactive television applications that in addition to informational overlays also feature local storage and networking —either within the home or with the Internet. In this paper, we are giving an example of applying the virtual channel model to the design of personalized television advertising.

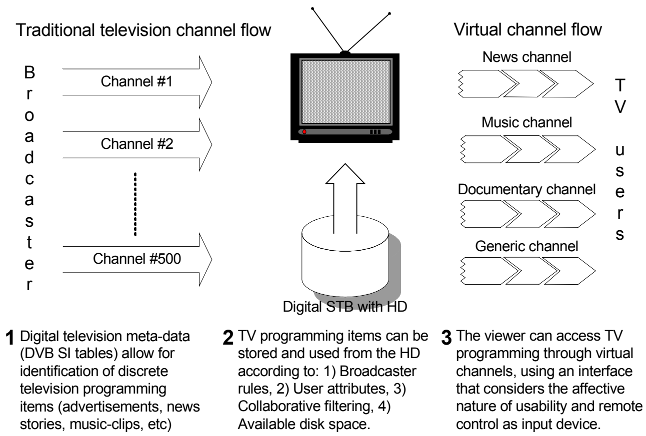

Figure 2 Relationship between previous work about digital television and authors' work about the virtual channel

Building a virtual channel is a three-step process. Digital television transmission (figure 2, step 1) and content personalization (figure 2, step 2) have been treated extensively in the broadcasting and information filtering literature respectively. On the contrary, dynamic content selection for television presentation (figure 2, step 3) is a new concept both for television viewers —who are accustomed to receive passively programming— and to broadcasters —who have built their business around pushing content to the masses. Multimedia content presentation has been treated to some extent by the CD-ROM industry and lately by rich media Web sites on the Internet, but in each case the content is targeted to personal computer users and not televisions. Current information filtering theory is also inappropriate for interactive television when considering the different characteristics of users (groups of television viewers), equipment (set-top box and television), goals (relaxation, enjoyment, escaping from reality) and transmission (broadcasting).

Therefore, the virtual channel model builds upon previous technical work done within the broadcasting industry (figure 2, step 1), in order to bring the benefit of digitization to the end users. It also complements the literature about personalized content selection and presentation (figure 2, step 2 and step 3), by offering a model for enhancing the television experience in a feasible way.

Applying the Virtual Channel Model

The virtual channel model has been initially employed into the design of two interactive television applications: 1) Personalized television advertising and 2) interactive music video clip programming. The former is a demonstration of the validity of the virtual channel model for enhancing traditional television programming in a way that is transparent to the end user. The latter, is a demonstration of the validity of the virtual channel model for future television applications. The latter is presented through the description of an initial implementation of a reusable virtual channel Application Programming Interface (API).

Personalized Advertising

Choosing advertising as a case study may seem controversial. On the one hand television advertising is irritating to a lot of people —research has shown that as much as 30% of people zap during the advertising-break (Van-Meurs 1998). On the other hand, Bell and Gemmell (2002) propose that advertising may be a remedy to the Digital Rights Management (DRM) issues that arise when manipulating copyrighted media content in the home: ‘Publishers will insist on DRM to protect their content and ensure their revenues. As DRM matures, cache stuffing will allow for some interesting opportunities such as insertion of advertisements that can please both viewers and distributors.’

The traditional advertising-break consists of a number of short video sequences (commercial-spots) that have been inserted in the broadcasted stream from the transmission point. Every single household within the broadcast footprint watches the same spots, in the same sequence at the same time. Media planners acknowledge the fact that a large percentage of the viewers do not belong in their target group. Showing irrelevant advertising to people that may neither be interested in the suggested offerings, nor be of interest to the advertiser has become a norm in the broadcasting and advertising industry. The traditional mass communication model of advertising has been successful in financing the media industry, but it is now growing inadequate to provide a relevant experience to television viewers (Dawson 1996).

In the past, television viewers had become accustomed to the burden of irrelevant advertising, but lately, technological innovation —with devices such as TiVo and ReplayTV— has allowed them to record television programming and fast-forward through the advertising breaks. On one hand, the wide spread use of TiVo-like devices may mean the end of advertising supported television programming. On the other hand, local-storage and processing of advertising spots may be used to insert advertising-breaks for each set-top box, according to household and individual characteristics. This justification has been considered in the design of the iMEDIA system for personalized advertising-breaks —in-place of the traditional broadcasted advertising-break. The users of iMEDIA may choose to watch a personalized advertising-break, in addition to opportunities for browsing through interactive advertisement content.

The main benefit of personalized prerecorded advertising (Figure 3) is that it does not distort the predominant passive television consumption patterns (Lee and Lee 1995), because from the user's point of view the experience remains the same —with optional personalization and interactivity. In addition to targeted messages, the iMEDIA system offers the option of interactive content, which can be accessed either in-sync with the advertisement break, or preferably at a later time.

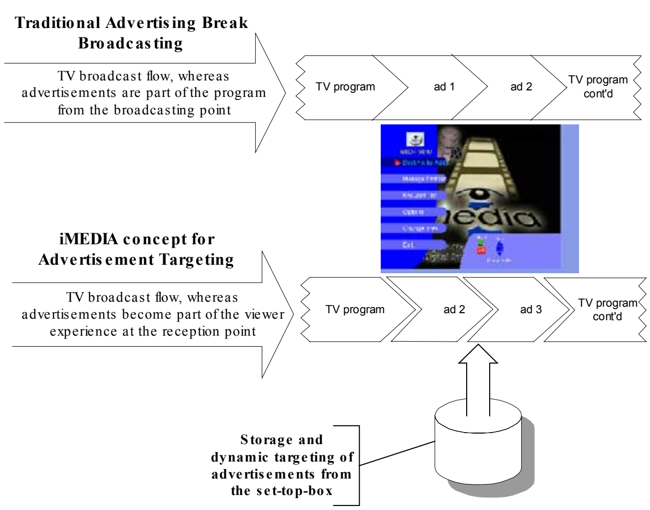

Figure 3 A personalized advertising-break in contrast with the traditional advertising-break

For the iMEDIA system, the advertising-break is created dynamically from a pool of advertisement spots that have been downloaded from a hidden broadcast channel and stored on the hard disk of the set-top box. The exact commercials to be inserted on a given advertising-break are selected by the classification and targeting sub-system, which is based on media planning industry's standard procedures, as described in the next section.

Methodology for Personalized Advertising-breaks

As discussed in Brusilovsky (2001), two major categories of personalization can be identified with respect to what is being personalized: personalization of navigation, which involves various techniques for providing support to users in order to perform the navigation task, and personalization of presentation which includes the personalization of content delivered to users (text, images, video, etc.).

Regardless of the scope of personalization, all extant approaches to the personalization process address five fundamental steps (Kobsa et al. 2001; Adomavicius and Tuzhilin 2001): 1) the identification of available user data with respect to the objective of personalization, 2) the utilization of these data by designing a model of the user that is able of predicting the user's future behavior, 3) the adaptation of the personalization subject according to the prediction of the user's behavior, 4) the collection of evaluation data, and 5) the user model update in order to produce more accurate predictions in the future.

In order to achieve personalization for advertisements in the interactive television domain, theories and tools from advertising were utilized. Marketers use market segments of consumers with similar characteristics in order to fine-tune their offerings.

One of the well-known methods of predicting a user's behavior is the classification of users into stereotypes. Stereotypes are predefined classes of users where assumptions about their behavior are attached to the stereotype (Rich 1989). It is a very powerful and relatively simple tool for making initial predictions on a user's behavior. The method involves the identification of the standard classes of users, the classification of each user into one of the stereotypes, and the derivations of the behavior of a specific user from the attributes of the stereotype. Stereotypes have been widely used and they are reported in a number of cases (Ambrosini et al. 1997; Fink et al.1998; Ardissono et al. 1999).

For testing purposes, a version of the VALS (Values and Lifestyles) segmentation was used, which is 'by far the most popular lifestyle and psychographic research' (Hawkins 1998) and divides the whole population into eight clusters of consumers (http://www.sric-bi.com/VALS/types.shtml).

Ideally, the assignment of a set-top box user into a cluster is performed by means of a psychographic questionnaire that measures certain variables and classifies each user into the respective stereotype. Taking into account that enforcing all the users of a personalized system to explicitly fill-in such questionnaires is rather difficult and annoying, we use a panel of the population, which provides input for the classification and targeting process. The whole population itself is assigned into the VALS clusters by using classification rules that are applied on data that is available locally, at each set-top box. Locally available data include: 1) Demographic data provided by the user —upon subscription to the service. 2) Advertisement satisfaction that is implicitly collected by means of Bookmark and Contact-me buttons. 3) Media consumption data, such as programs watched.

Our approach requires that a panel of users provide psychographic data by means of questionnaire completion. Upon the completion of the questionnaire on the site of VALS (http://www.sric-bi.com/VALS/presurvey.shtml) panel-users are classified automatically into lifestyle clusters (stereotypes). Then, discriminant analysis is employed to derive classification rules for the population, on the basis of data available at each set-top box.

The classification rules have the form (if X then Y) where X may include demographic, interaction and media consumption data, and Y denotes the cluster that a user belongs to. Such rules are then continuously applied to the local data monitored by the system for each individual, so that the segment to which the viewer belongs can be determined dynamically and re-assessed if needed. The advertisements that correspond to each cluster are shown to the viewers accordingly. As the amount of data that are being monitored for panel-users increases, updated classification rules are developed and applied, thus adjusting the classification into clusters. Classification rules come at a cost of reduced accuracy, compared with the use of the original VALS questionnaires for the whole population. Nevertheless, the result is better targeting than traditional mass advertising.

In summary, the iMEDIA approach offers a way for enhancing advertisement effectiveness for the digital television environment, without sacrificing consumer privacy —given that we use locally available data at each set-top box. Advertisement targeting is usually based on accurate consumer data about demographics and psychographics. The need of marketers for accurate data collides with users' concern for privacy intrusion. Protection of users' privacy was recognized and a solution for the benefit of both advertisers and users was implemented in the form of classification rules and exploitation of locally available data.

Architecture for Personalized Advertising

The users of the iMEDIA system fall into the following four categories: Content Providers (CP), Advertisers or Advertising Companies (AC) and Consumers (Figure 4). The iMEDIA Service Provider (iSP) plays the role of mediator among these users and utilizes the infrastructure provided by the Broadcast Service Provider (BSP). The CPs provide the TV content and advertising airtime within them. They use the iMEDIA tools for defining the advertising breaks, importing their program schedule, analyzing their program viewership and declaring their pricing policy. The ACs provide the advertising content and use the tools to characterize and upload it to the server. They are also given the possibility to analyze the consumer behavior, view advertisements and program viewership, view the pricing policy of each CP, and book airtime for specific target groups. They can also retrieve the requests made by the consumers during their interaction with interactive adverts. The Consumers are equipped with a set-top box with storage facilities and a modem. They can create their profile based on their demographics, preferences and buying habits, and store it to the local hard disk. Their profile also includes interaction and viewing data that are tracked automatically (Bozios et al. 2001).

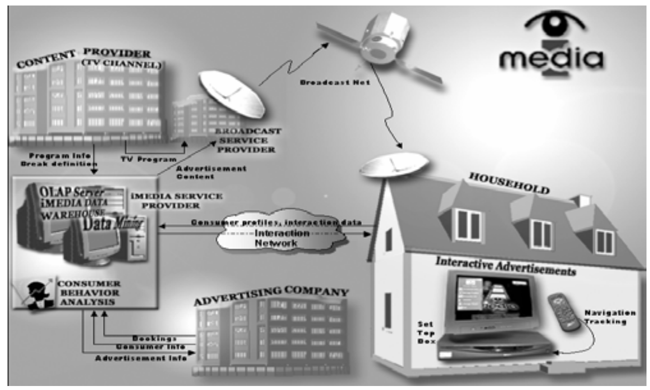

Figure 4 High-level architecture of the iMEDIA system. Described in detail in Bozios et al. (2001)

All the advertisements are sent by the iSP through the BSP and stored to each consumer hard disk. The iSP sends also information about the advertisements that will be delivered to each target group during an advertising slot. When an advertising break starts, for the consumers who have opted for personalization the client side modules will retrieve from the hard disk the advertisements that match their profile and will playback them. The consumers who do not wish personalization will watch the regular advertising stream. When the consumers make requests during their interaction with an advert, they are temporarily stored to the hard disk and are uploaded through the return channel to the server at a later time. If the consumers have agreed on that, their profiles are also periodically uploaded to the iMEDIA server and they are analyzed by the ACs.

Status of iMEDIA Research

The initial iMEDIA prototype was delivered in February 2001. For the realization of data mining, the Oracle data mining suite (Darwin) was used. The final prototype was delivered in August 2001. In that prototype the PC/Java-based client was tested to a DVB-MHP set-top box. From March to July 2001 it was being evaluated through trials in a laboratory environment (Lekakos et al. 2001). After the successful evaluation of the system implementation our research focus has turned on the assessment of the project's core concept i.e. to provide targeted advertising. The consumer clustering schemes used include clusters automatically generated by the data mining mechanisms or predefined by a domain expert. This research is an ongoing effort that continues to the date (Lekakos and Giaglis 2002).

The Virtual Channel ActiveX Control

In addition to the theory of the virtual channel model we are also working on the development of an ActiveX control implementation that encapsulates most of the virtual channel model's properties. In the previous section, we employed the mentality of the virtual channel model for content filtering (step 2, in figure 2), for the case of personalized television advertising, and presented a methodology that considers the characteristics of the broadcasting television environment. In this section, we demonstrate the features of the virtual channel model's Application Programming Interface (API), by employing it in an interactive television application for music video clips.

In order to clarify the features of the virtual channel ActiveX control, we provide a number of pivotal screenshots that offer a walkthrough of the features, the states, and the events that are offered by the current virtual channel implementation. In addition to the virtual channel, we also employ the Microsoft Agent ActiveX control as a fun way of displaying a dialog interface. Please note that the specific dialogs displayed in the examples bellow are not supposed as a television-user interface, instead they have been chosen to communicate the virtual channel model and the API supported by its current implementation.

Rationale for Interactive Television Music Video Clip Programming

According to the CEA Market Research (itvmarketer 2003) 36% of the consumers would like the ability to skip to parts of a show, similar to skipping from song to song on a CD. For this purpose we designed and implemented an application that allows a television viewer to skip through music video clips —an action that may come at the cost of watching a targeted advertisement if the viewer has chosen not to pay a subscription fee. Most significantly, the video skipping feature has the additional benefit of revealing whether the viewer is actually paying any attention to television programming.

Music video clips as a form of television programming have some unique characteristics that we present in order of importance -according to our view. Firstly, it is the only type of television advertising (together with infomercials) that is sought after by the audience (Jenkins 2002). Next, music television programs are popular in all countries, as depicted by the existence of the multinational MTV channel in all market and also the recent appearance of many local MTV-like channels (MCM in France, MAD in Greece). On the technical side this choice, music video clips content can be easily classified and filtered by employing the widespread databases, classification schemes and adaptation models that have been developed for the case of the popular MP3 music. Additional metadata that describe the visual content may also be used.

Moreover, music video clips have a clear target demographic (ages 15-25) and a larger life-span — compared with news items— that make easier an experimental set-up and evaluation by the end-users. On the basis of the above rationale, we considered that music video clips is a natural choice, after personalized advertising, as our next step in interactive television programming.

Using the Virtual Channel API

In order to portray the API in an easy to communicate way, we are exposing the events raised by the virtual channel ActiveX control as dialog instances in the screenshots. The specific balloon dialogs displayed in these screenshots are inappropriate to communicate to the television viewer, so they should not be regarded as a television viewer's interface, but as a demonstration of the programmer's interface. The underlying events that are raised by the virtual channel ActiveX control exhibit the essence of the established broadcasting mentality, that is "start of video", "end of video", "end of ad break", "scheduled ad break coming next", etc.

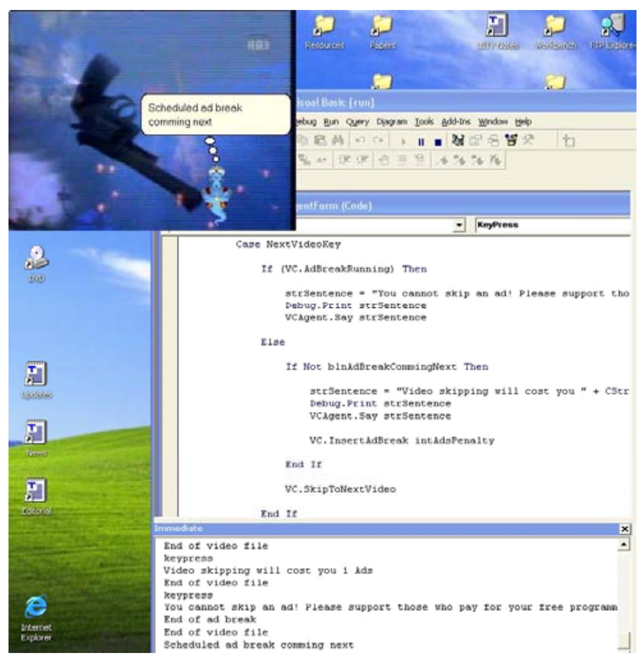

Figure 5 Microsoft Visual Studio for Visual Basic development environment showing code, debug output and an interactive television application for music video clips

Depicted above, the music video clips virtual channel is running next to the Microsoft's Visual Studio Visual Basic development environment (Figure 5). On the bottom ('immediate window') there is a list of the events that have been raised, while just above it ('code window') displays the code —of roughly 10 lines— that is needed to implement an application that skips forward a music video in the virtual channel queue and to display a message with the agent, after having shown an advertisement. In the following screenshots, a few of the states and events are handled and presented visually.

The application starts with a user greeting and a music video clip playing in the background (Figure 6). Note that both the agent and the balloon dialogs appear transparently to the background video (and not solid as in the screenshots) on the actual prototype application.

Figure 6 The all time programmer's favorite "hello world" application displayed from the agent upon the initialization of the application. On the background, the virtual channel control has started playing out a music video clip

When an ad break ends the hosting application receives the respective event (Figure 7). The underlying virtual channel control continues automatically to play the next music video clip, although the event may be handled programmatically to change the behavior of the virtual channel in order to display a user interface, an agent dialog, or to alter dynamically the virtual channel queue of upcoming content.

Figure 7 The end of an ad break event can be handled to change the behavior of the virtual channel or to display an application specific user interface

In addition to dynamic ad inserts, the Virtual Channel ActiveX control features an integrated system for scheduled ad breaks (Figure 8). At the initialization time the programmer may set ad break timers for scheduled ad breaks every 15 minutes, 30 minutes or any duration that is fit for the application at hand.

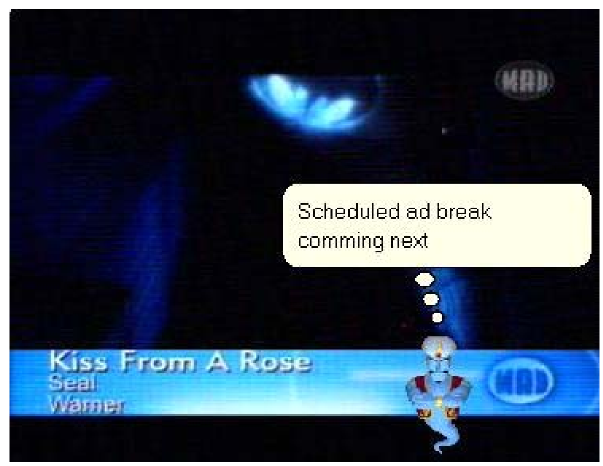

Figure 8 When the internal timer reaches the adbreak threshold an event is raised

The Microsoft Agent may stay idle while the music video clip plays (Figure 9), and can be also placed in the left corner, or it can be even switched off the screen completely. Although it was originally designed by Microsoft for personal computer use the Genie Agent integrates flawlessly with television and is fit for the purpose of offering personalized recommendations of music video clips and in general "to fulfill the commands of its master."

Figure 9 The Microsoft Agent is always performing some idle time activity by default, but it can also be switched off if it becomes irritating

Further Research

In this prototype application we used music video clip programming in order to design, develop, validate and improve a preliminary API that is based on the properties of the virtual channel model. We also employed a presentation agent that has been one of the research community's favorite features for some time now. The majority of these works cite Reeves and Naas (1996) as the background theory for designing anthropomorphic dialog systems. Presentation agents have been less successful in the marketplace at least in working environments, as depicted by the limited use of the Microsoft Office Agent. Nevertheless, we plan user evaluations that may prove the usefulness of the presentation agent research, at least for the interactive television case or in general for the home infotainment domain.

We are also designing alternative television user interfaces that are appropriate for manipulating virtual channels that feature both local storage and Internet connectivity. Successful designs are going to be implemented in the virtual channel Active X control, in order to be reusable by researchers and practitioners for rapid interactive television prototyping.

Discussion

Apart from the music video clip programming, the proliferation of other thematic television channels (news, weather, documentary) gives many opportunities for applying the virtual channel model, given that the content in this type of channels is alike. For the case of general-purpose channels that broadcast diverse types of programming, the virtual channel model has to be applied on a per-segment basis. It is also obvious that the virtual channel is not appropriate for story-driven media programming and dynamic synthesis of scenes for the creation of new content items, like movies, soaps and series. Strategies and tools for responsive television programming for the latter cases have been studied by Agamanolis (2001).

The proposed model may be refined and enhanced, as it is being applied and tested with other types of television programming. By making an analogy with the desktop computing paradigm, it is evident that there are multiple commercial implementations of the same basic human interface principles for interacting with personal computers —Windows, Mac and Unix variants to name the most popular. In this fashion, the virtual channel may be implemented to support diverse commercial policy objectives. It may also be complemented with other use paradigms, in order to support easy access to digital television applications that offer interactive content navigation.

In addition to different types of television programs, the proposed model may be applied to other media types. Given a large local storage of MP3 music, multiple virtual channels may depict different music genres by reading the metadata of each music track either locally or from Internet databases. One can also have virtual music channels based on personal preferences, created by friends or radio DJs. By exploiting Internet databases and user groups the STB may act as host for searching and applying collaborative filtering techniques to all types of music related content (audio, video clips, text), in order to augment the listening experience with additional relevant media content.

Finally, in our opinion, the lack of understanding and application of the virtual channel model's properties explains the continuing failures of interactive television in the marketplace, whereas most of the times applications replicate strategies from the web or yet worse from the desktop computing paradigms.

The virtual channel originates from the broadcasting mentality for media distribution, which has been established through the years as the most widely recognized and familiar method for universal media access. The virtual channel points towards a future of personalized access to an increasing number of media choices. Overall, the virtual channel has proved to be an invaluable tool for thinking about personalized television programming. Television producers should start to think of their programming in terms of discrete modules—audiovisual, executable code, data—and in terms of their dynamic synthesis personalized for the television user in the form of virtual channels.

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