

# A Personal TV Receiver with Storage and Retrieval Capabilities

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**Abstract.** The convergence era has begun raising the need for intelligent assistance in the large amount of multimedia content already available in the home environment. In this paper we present a Personal Video Recorder that exploits meta-data obtained from a service provider or locally generated, to provide users with profile-based filtering and innovative user-friendly video browsing tools. Its user interface concepts enable ways of interacting with recorded video archives that are far beyond the traditional linear and passive way of watching television.

## 1 Introduction

We are witnessing a proliferation of digital multimedia information. The overload of video services available can disorient home users. Currently many channels can be received via satellite and the number is growing steadily. For example, in Italy there are about 80 channels in Italian language, with some 25 free to air. By just selecting one single satellite, Eutelsat HotBird, it is possible to get about 500 TV channels! Thanks to the digitalisation of television, in the near future we will see a further growth of channels via satellite, terrestrial antenna, cable and even via phone lines (with ADSL technologies). Also new interactive services such as video on demand will begin to appear. Advanced set-top boxes equipped with hard-disks, optical disk recorders and hand-held devices with large storage capacity are appearing on the market, making people eager to collect and create their own personal video archives. But because, from the point of view of the end user, the usefulness of a multimedia database is measured by the retrieval facilities it supports, proper tools for video content filtering, management, navigation and search have to be provided. If we want to take full advantage of the availability of video content and of storage devices in the home environment, we need to develop tools that facilitate and encourage interacting with large video archives.

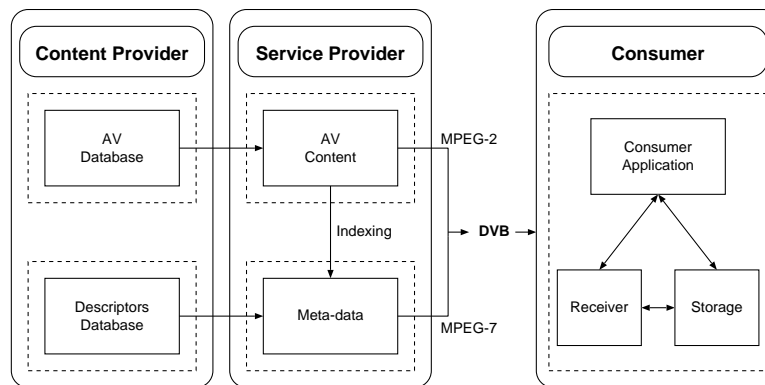
In this paper we present a consumer prototype developed in the European project AVIR. This system is an example of *Personal Video Recorder* that exploits meta-data obtained from a service provider or locally generated, to provide users with profile-based filtering and innovative user-friendly video browsing tools. We believe that uniting of storage capabilities, content filtering, user profiling and advanced search functions can fulfill the requirements of the next generation of home users.

The rest of the paper is organized as follows. In section 2 an overview of the AVIR European Project is given. Section 3 describes the AVIR consumer system platform and its main features: the EPG (section 3.1), the user profiling and the personalised TV advisor (section 3.2), the recorder and storage management facilities (section 3.3), the visual content navigation tools (section 3.4) and the meta-data management (section 3.5). Conclusions are presented in section 4.

## 2 Overview of the AVIR European Project

At present, some products with personalized television services are available in the U.S. market (i.e. TiVo, ReplayTV, MicrosoftTV) [5–7] and all use proprietary systems. Because of the diversity of the market, the deployment of such services in Europe is still in its infancy. In the AVIR (**A**udio **V**isual **I**ndexing and **R**etrieval for non-IT-expert users) European project, personal TV functionality have been realized using international open standards like MPEG-7 [10] and DVB-MHP [9], demonstrating the feasibility of an infrastructure for provision of distributed interactive services.

The project aims to develop new solutions for automatic analysis and indexing of audio-visual information, specifically meant to support consumer services. Figure 1 shows the AVIR system concept: a set of content descriptors (or *meta-data*) is generated by the service provider or by the content provider system according to the forthcoming standard MPEG-7. The meta-data are streamed, multiplexed and distributed, along with the associated content, according to the DVB specifications.



**Fig. 1.** The AVIR system concept: content descriptors are delivered together with audio-video material providing to home users new personal TV services based on content filtering and content retrieval.

The consumer platform consists of a set-top box enhanced with storage capabilities so that the broadcast content and the related descriptors can be filtered and stored locally according to the user profile. Advanced search and retrieval functions are implemented based upon the received multimedia content descriptors.

Demonstrators of the AVIR consumer system have been developed on a flexible Linux PC architecture and on a set-top box prototype much closer to a consumer electronics product realization.

In the following section, the first PC-based platform, which includes the more advanced retrieval features, is described. A comprehensive documentation about the project can be found in [4].

### 3 The AVIR Consumer System Prototype

Storage capabilities, content filtering, user profiling and advanced search functions are key-features that will be required by the next generation of residential users. The AVIR consumer system prototype designed by Philips Research is an example of *Personal Video Recorder* that exploits meta-data obtained by a service provider or locally generated, to provide users with profile-based filtering and innovative user-friendly video browsing modalities.

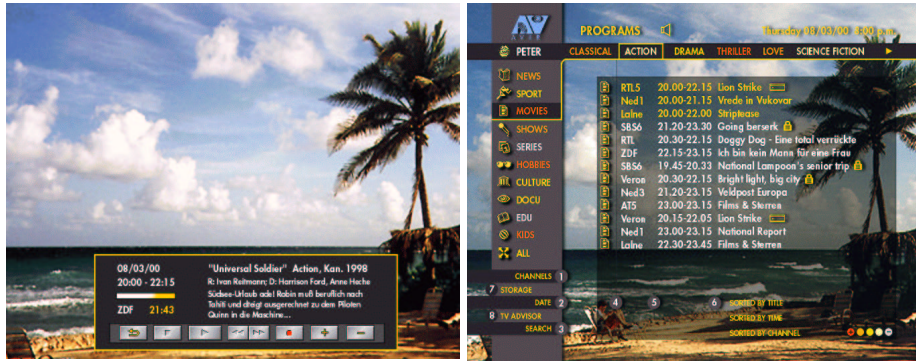
The following sections present in detail the main features and key innovations of the AVIR consumer system.

#### 3.1 EPG System

When the user needs to make a choice from over one hundred channels, a good electronic program guide (EPG) is essential. The AVIR platform incorporates an advanced EPG designed to help users to cope with the growing number of available TV channels.

Conventional TV program guides, such as the ones provided by newspapers and magazines, present the scheduled programs grouped by channel and sorted in chronological order. When the number of available channels increases, finding interesting programs to watch or to record becomes rather difficult. In the AVIR EPG, the chronological order is kept but programs are grouped into genres and sub-genres allowing users to search for specific things they could be interested in. Each program has associated as minimum, the title, the time of broadcast, the channel, the genre and a short summary. When more information is available like, for instance, the director, a list of actors or an image, the user can choose to see it or to keep the shorter description (see figure 2).

The classification into genres and sub-genres can be based either upon specific meta-data provided by the content or service provider or upon a local software agent that exploits textual descriptions of the programs retrieved from the web. The software agent uses for this purpose a list of keywords that are used frequently to describe programs of a particular genre. A program is then mapped



**Fig. 2.** Two screen-shots of the AVIR EPG. The left one shows the programme information displayed during viewing or zapping ("i" button). The right one shows EPG during genre selection.

into a genre/subgenre category depending on the occurrences of such keywords in its description.

The genres and sub-genres taxonomy is an effective data organization specifically meant to deal with the information overload foreseen for the near future. Actually there are no universally accepted standard taxonomies. For simplicity we use a genre classification system developed within Philips Research which is based on real TV program statistics data.

### 3.2 User profiling and Personalized Viewer Advisor

The AVIR consumer platform is designed for usage in a family setting. Thus, it supports a multi-user environment. Users are identified by a nick-name, they can personalize the graphical aspect of the interface in order to recognize their profile and they can also prevent others from watching or removing stored programs by locking them with a pin-code.

By default one profile is active for the complete family, so it will work directly out-of-the-box. This is the *family profile*. The default value of this profile is based on the global viewing figures for a given geographical region.

One of the key elements in the AVIR system is the usage of user profiles for recommending TV programs and for automatic recording. To help users in deciding what to watch, a TV advisor system based on the user's profile rates the incoming programs presents to the user a list of recommendations. This so called *TV advisor* [2] can automatically record the selected programs in a disk-based cache. A user profile contains the following information [2]:

- preferred viewing times;
- preferred channels;
- program type preferences;

- keywords of particular interest.

The user's profile settings can be modified specifying how much the user likes or dislikes programs in each genre and sub-genre. To avoid users having to set up their profiles by going through all the genres, they can select a stereotype in a list of predefined ones such as Movie Lover, Film Freak, Documentary Buff, etc. and tune the ratings later.

### **3.3 Easy Recording and Storage Management**

All the AVIR platform functionality are accessible through a "flat" graphical interface (see figure 2). Users can interact with the system by means of a standard remote control, using an infrared keyboard or a voice control system.

Besides the electronic program guide and the automatic recommendations, the main feature of the AVIR consumer system is to provide recording facilities. The system is a digital video recorder based on hard-disk. Programs can be manually or automatically (based on the recommendations) selected for recording. The system supports all the functions of a traditional video-tape recorder and makes them accessible through its intuitive graphical user interface.

To record a program all one has to do is push a button. Programs that are recommended by the TV advisor can be recorded in the same way.

In a device that features automatic recording, it is extremely important to be able to get a good overview of the content of the disk. In the AVIR system, all programs that have been recorded can be browsed similarly to programs that will be broadcast. The user interface offers the possibility to either get a complete overview of recorded programs in order of time of recording, or to select them by genre. However more functionality than in the standard EPG are offered as the program and all related information have already been captured. Therefore it is possible to get a textual summary of the programme as in figure 2.

It is possible to archive the program in order to make more room on the local disk or just to keep a copy of a movie in the personal video library. In this last case, the programme will be transferred onto an external drive such as a recordable DVD or a VHS/D-VHS tape. In all cases, essential information such as title and genre will be preserved on the local database together with the recordable media identifier. In this way all the information of the home video library is centrally managed and available for future reference and search operations.

### **3.4 Visual content navigation**

In general it is very useful to be able to quickly navigate in a non-linear manner through video programmes at a much higher speed than fast forward or reverse feature allow on current home video recorders. But in case a device automatically records programmes whose content is yet unknown to the user, intuitive navigation and presentation tools must be offered to the user in order to quickly

inspect the content and decide whether or not to watch or keep the program or part of it.

Browsing the visual content by means of so-called key-frames (see figure 3) allows users to get an idea of the content of a program or to find a certain segment they are looking for.



**Fig. 3.** The color browser is integrated in the key-frame browser.

Figure 3 shows the key-frame browser enriched with an additional innovative tool, developed in the AVIR project, called *color browser*. The color browser enhances conventional slide-bars used in video players by embodying information about the video content in its colored background. It exploits the dominant colors automatically extracted from the digital video streams to allow intuitive access and content-driven navigation. In our implementation we chose to show two bars, one that features a slider that can be used for fast browsing within a certain interval, and a second one that shows in which part of the program we currently are. This allows the user to effectively visualize the changes in the different parts of the program both at low and at high level of granularity.

Another feature, provided to allow non-linear browsing of the recorded programs, is the *jump to the next (previous) similar image* functionality that helps users finding particular sections within programs. Users can jump from an image in the video sequence to the next (previous) “similar” one. Such a functionality offers users the possibility to jump to the next news item in a news program by looking for the next occurrence of the news reader or jump to the end of a commercial break when the broadcaster uses a full screen logo, or search for weather forecast or sport reportage within a news program, etc.

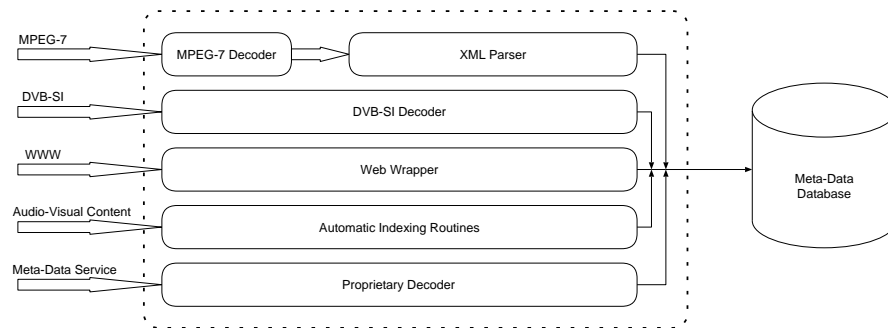
The *jump to the next (previous) similar image* functionality is coupled with another unique feature: the *favourite image list*. Each user has associated a list of favourite images that can be used as starting images for the *jump to the next*

(previous) similar image functionality. The *favourite image list* can contain, for example, a channel logo, the anchorperson of a news program, the titles of a series or a weather forecast scene. It can be interpreted as a set of bookmarks linked to the positions by means of content-based similarity.

In addition to the visual-search features, the system allows the more traditional way of searching by using textual queries. A keyword-based search function is available for searching the program descriptions of the EPG, the teletext subtitles or, when available, speech and closed captions transcriptions.

### 3.5 Meta-data Management

The architecture of the AVIR consumer system prototype has been designed to rely not only upon the content descriptors provided by the broadcaster or by a service provider. Different sources of content descriptions can be exploited to enrich the amount of information associated to TV programs (see figure 4). Local generation of meta-data consists of scene-change detection, extraction of the first frame of each shot as key-frame, computation of dominant colors and image descriptors, teletext extraction and stemming. A wrapper module parses public broadcasters' web pages to obtain textual descriptions used to classify programs into genres and subgenres. The meta-data database is implemented with a RDBMS. For each source of meta-data, the database tables are filled according to an internal and independent data format.



**Fig. 4.** Several sources are employed to obtain descriptions of the content. Each source has associated a specific module responsible of translating the incoming information into the internal meta-data format.

## 4 Conclusions

Formal user tests on the usability of the prototype and of its browsing and retrieval features are in progress. Alpha tests and public demonstrations have already given promising results.

The complexity of the next TV era pose a hard challenge in the design of new intelligent devices targeted to home users. Personalized TV services, such as the ones presented in AVIR project, can help users to cope with the information overload and the huge amount of possibilities created by the availability of large video archives.

The AVIR consumer platform is an example of intelligent and personal video recorder that exploits meta-data obtained by a service provider or locally generated, to give users profile-based filtering and effective user-friendly video browsing tools. The combination of storage capabilities, content filtering based on user profiling and advanced retrieval features can fulfill the requirements of the next generation TV users.

We believe that meta-data management in personal multimedia databases is a key-issue that will become even more important with the future in-home networks.

## 5 Acknowledgments

We wish to thank all the people who contributed to the development of the AVIR consumer system prototype, in particular Frank Crienen, Erik Bastiaans, Sander van de Wijdeven, Duco Das, Luc Geurts and Tomorrow Internet AG [8]. Special thanks for the cooperation also to Igor Paulussen, Ad Denissen, Jennifer Blijlevens, Eric Niessen, Rob van den Boomen and all the members of the Storage Systems and Applications Group of Philips Research.

The screen-shots of figure 2 are taken from a design realised by Tomorrow Internet AG [8] for the AVIR project.

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