An affordable and inclusive system to provide interesting contents to DTV using Recommender Systems

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***Abstract*— This paper presents a television scheduling system that aims to aid developing countries in digital television transition by providing content interesting for the people while reducing content acquisition costs. It is based on recommender systems for audiovisual content with special considerations for groups of viewers. The system proposed is fed with content uploaded by the people, properly classified. In a first and basic scenario the system generates four different thematic signals with predefined genres. In the second one, the profile for each user is known and audience is modeled as a group of viewers with known user profiles, allowing its segmentation and channel scheduling according to actual preferences.**

***Index Terms*— DTV and broadband multimedia systems, Service deployments, Content management, Audience prediction, System Recommenders**

I. INTRODUCTION

The analog blackout of television has been completed or coming to its end in several developed countries.

On the other hand, developing countries face a different reality. Digital Television (DTV) is being deployed today and will take some more years yet. Television is by far the instrument of Information and Communications Technologies with higher penetration in society, in many cases reaching every household. Unfortunately, broadband Internet access does not have such an extended penetration in these societies. While in developing countries 72.4% of households have a TV set, only 22.5% have a computer and only 15.8% have Internet access (compared to 98%, 71% and 65.6% respectively in developed countries) [1].

Since DTV allows new services and functionalities, such as multiprogramming and interactivity, it will have a major role in providing access to the Information Society to ample sectors of the people.

Besides, broadcast television, free to the public, has usually been restricted to few operators with few channels, due to limitations in the radio spectrum and the high costs of television production. The deployment of DTV allows a multiplicity of signals available to the viewer. It is said that DTV will bring an increase in democratization of the media and social inclusion.

However, there is still a problem regarding the high production costs that television programs have. If the number of services is multiplied (this is the desired benefit), the costs for producing the content for these services is also multiplied.

New forms of generation and transmission of content must be enabled. This content must:

- Have low production costs.
- Be participatory, allowing the citizen to create clips to be transmitted.
- Be of interest to the target audience.

In parallel, home-made content is becoming popular. People generate their own content and are willing to post them in web sites such as YouTube or social networks. Often, these contents do not reach all potential interested people because they do not have broadband access (common situation in developing countries) or they simply don't find them among the enormous existing offer. These clips have a very low cost of production and since the citizen who produces them is interested in sharing them, there's no cost for the emission rights.

In this paper we propose an affordable system that feeds inclusive DTV with content interesting to the public, giving citizens new opportunities to express themselves in society. It aims to two objectives: (i) to facilitate the developing by providing interesting content, and (ii) to stimulate the participation of the people in the generation of content.

The system proposed consists of three modules whose functions are:

i. Receipt and verification of content.
ii. Recommendation and preparation of the programming grid.
iii. Emission.

The core of the contribution is in the recommendation agent and the preparation of the schedule emission.

The upload of audiovisual material can be made by the citizen from the Internet connection at home or from an

Internet cafe. In order to create metadata for this content, certain information is requested from the user, to classify the clip in a TV ontology [2], plus some relevant information such as author or location.

There are many articles that refer to the recommendation of audiovisual content [3] [4]. However, in general they point to a user who has lots of clips available and consumes alone. In our case, similar to [5], we make the necessary adjustments to recommend for a very large audience and continuous emission as in the case of television stations.

Our approach is based on the AVATAR recommender which has been implemented for individuals [6] and groups [7]. AVATAR stores user profiles, built based on user interests in different classes of the hierarchies of the TV ontology, inferred from his qualifications in certain clips offered and his viewing history. Based on user profile and the metadata of a proposed content, AVATAR computes the *Predicted Degree of Interest* (PDOI) of the user for the content. PDOI is an estimation of the interest the user will have for the proposed content. We make recommendations to generate the programming schedule of four services emitted together in a DTV multiplex. This programming will consist entirely of content provided by viewers, uploaded to the website.

In a first scenario, we generate four signals specialized in four fixed topics: *Sports*, *Culture*, *News* and *Education*. A prototype user profile is created for each one of the categories (for example, a virtual user with specialized interest in Sports). Using AVATAR a list of PDOIs of each virtual user for the content available is generated. Clips with higher rankings will be those of higher interest for each virtual user. The algorithm that computes the programming of each channel is based on this ranking, while weighting the distribution list of viewers throughout the day and week.

In the second scenario, a more complex and rich situation is contemplated. There are multiple user profiles from the whole audience registered in the system. The viewer can make a login from his Set Top Box, so the system knows in real time those who are watching television. Profiles are grouped using *clustering* techniques in four subgroups. Thus, we divide in four segments the audience that is watching TV in every moment. A virtual user is computed for each subgroup, whose profile represents the part of the audience included in it. For each of the four virtual profiles a sequence of clips is recommended, building in real time the list of contents to be broadcasted through each of the four services available. Thus, each service will transmit content that is of interest for each of the four subgroups recognized in the actual audience.

The paper is organized as follows: Section II briefly relates the motivation of the appearance of recommender systems and shows the history of AVATAR. In Section III and IV we describe the two possible scenarios of action of the system proposed. Finally, Section V includes the conclusions.

II. AVATAR

Considering the wide spectrum of consumption options that new technologies offer to the user, many times he is easily overwhelmed by the amount of available information or the large number of similar products, perceiving it as an overload that makes really difficult to be aware of appealing items, or even to make a selection among the things he is interested in, whether they are news, audiovisual contents, sales offers, services, training or education.

This problem empowered the development of recommender systems in the nineties. These systems have traditionally sought to simplify the work of individuals, allowing them to focus on appealing or useful things filtered from the whole set of available ones. Or even better, helping them to discover new interesting items deeply hidden under a vast amount of irrelevant ones.

This task can be performed following quite different approaches that usually depend on the nature of the information sources (the descriptions of products, the knowledge of viewers' preferences, the ratings of the viewers, the history of their consumption…) and the algorithmic technique implemented that can be usually classified as content comparison or viewer comparison. In any way, initial approaches were fundamentally based on purely syntactic comparisons, and, even though the results of recommendations were most of the time partially successful, they were restricted to search for the occurrence of the same words, or words with the same root, which usually led to limited results, generally very similar to already known products (what is known in the field as 'overspecialization').

This poor initial performance has been improved with the application of new techniques, very often following a hybrid scheme. In this context, it is necessary to emphasize the use of ontologies, which permit to organize the items and their relationships in a hierarchical way. If ontologies are used, semantic reasoning can be performed that allows discovering a greater number of relationships among contents and between contents and viewers.

As previously explained, in the core of the system is AVATAR. It is a TV program recommender initially developed to suggest audiovisual contents to a single individual, using a hybrid algorithm (content-based and collaborative) based on the inference of semantic relationships between programs by means of semantic web techniques.

The AVATAR framework originally included a multidimensional ontology about the domain of television where classes represented the concepts of television (contents, formats, users, credits, dates, locations…), and properties specified relationships among those concepts. The different hierarchies followed the several classifications schemes of the TV-Anytime standard [8]. To be precise, we implemented four hierarchies that describe the contents from different complementary angles such as gender, format, intention and intended audience. The viewer profiles consisted of excerpts from the multidimensional TV ontology containing the programs that individuals had rated in the past, each one attached to a numerical index called DOI (*Degree Of Interest*) that quantifies his/her liking of it. This way, we provided the recommendation engine with a significant content comparison capability, being able to detect more subtle relationships between new contents and the contents contained in the viewer's preferences.

However, the recommendation engines have undergone a widening of domain for the past decade and they are no longer directed solely to a viewer, but now also to groups. Many of the activities performed by individuals, and this is especially true for entertainment, are done in the company of other people, and so, group recommendation is beginning to receive much more attention than in the past. Now, not only the interests of individual viewers must be taken into account, but also the combination of interests of the group of people must be studied.

So, we extended the AVATAR domain to become a TV content recommender for groups [7]. The approach of the group recommendation algorithm started from the discrimination between homogeneous and heterogeneous groups, as the latter ones are especially relevant in real life (like families) and present tools had failed to provide good results for them. We classified the group *G* as homogeneous or heterogeneous computing the correlation of the vectors of interests of the viewers' profiles of its members. For heterogeneous groups, a process to find equivalent ones in the universe of viewers was developed, leading to neighbour groups as the first step to a collaborative approach (neighbour groups have at least one member neighbour to each member of *G*). With this algorithm, and starting from the DOI of the viewers in the classes of the ontology, AVATAR is able to compute the Predicted DOI (PDOI) of the group for a new content.

With the help of the group recommendation capabilities of the new algorithm, we explored the AVATAR possibilities in the field of television audience prediction [5]. Extending the scope of the group recommendation problem, we modelled the audience as a group, and applied the recommendation techniques for groups, with special considerations, to predict the audience that a program will have, applied to a problem of great economic and social significance: the scheduling the weekly program grid of a television station in order to maximize its audience.

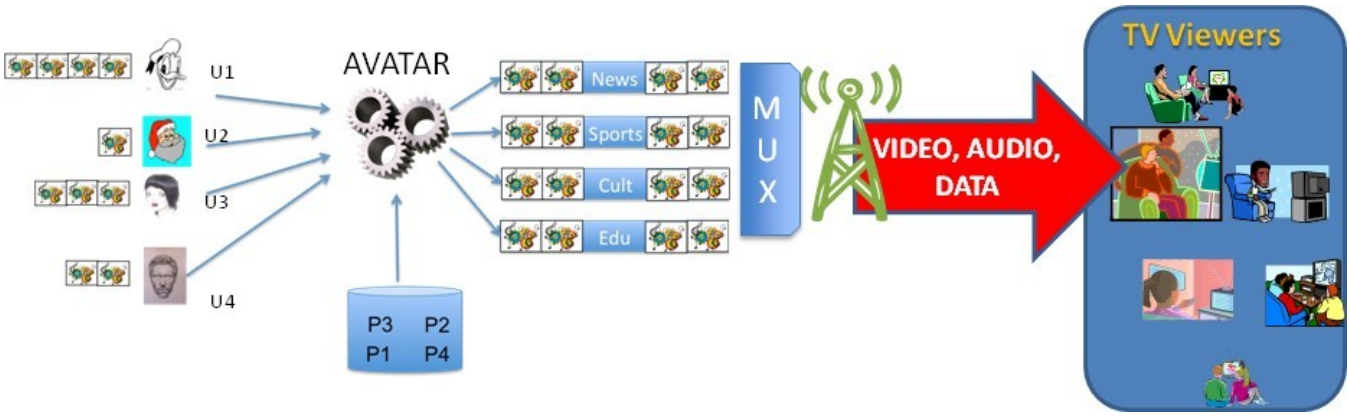

Figure 1 – First Scenario

III. FIRST SCENARIO

In the first scenario the system does not have feedback from viewers Set Top Boxes or TV sets. Thus, it is not able to store their preferences. In this case we have to generate four thematic services to feed the multiplex which is going to be broadcasted. We have chosen Sports, Culture, News and Education in order to cover a wide range of interests. Besides, these are basic genres existing in the TV-Anytime classification.

As can be seen in Figure 1, general content is uploaded to the system by different users, here named as U1 to U4. The user who uploads each clip, must include some describing metadata, providing the information for the system to classify the new content in the ontology.

Since AVATAR has no return channel from the TV viewers, user ratings for each clip are not present, and so it is not possible to build the profile for each user.

Thus, four virtual profiles are constructed inside the system, named P1 to P4 in Figure 1. Each virtual profile represents a virtual user who is especially interested in one of the services genres. P2 for example, would be a virtual user who likes clips related to Sports.

In this case, after the incoming content has been classified in the ontology it is ready to be used by the AVATAR algorithm. The PDOI of the new clip will be computed for each of the virtual profiles P1 to P4. The clip will be broadcasted through the service for which the PDOI for the corresponding virtual user is the highest. For example, a football match will probably give the highest PDOI for virtual user P2 since it has especial interest in sports; so it will be broadcasted through "Sports" service in the multiplex.

This approach has two main disadvantages. First, the system has no tool to estimate if there is relative artistic quality difference between different clips. This may lead to a situation in which a very good content will be broadcasted in a period of time in which there is very few people interested in its genre. And second, the four basic genres in which content is classified were adopted at design time. It is not based on segmentation of the actual audience, so it may be a bad classification. For example, maybe no one in the audience

would like an educational program; instead, they might prefer two sports services. These two disadvantages are minimized in the second scenario presented in the next section.

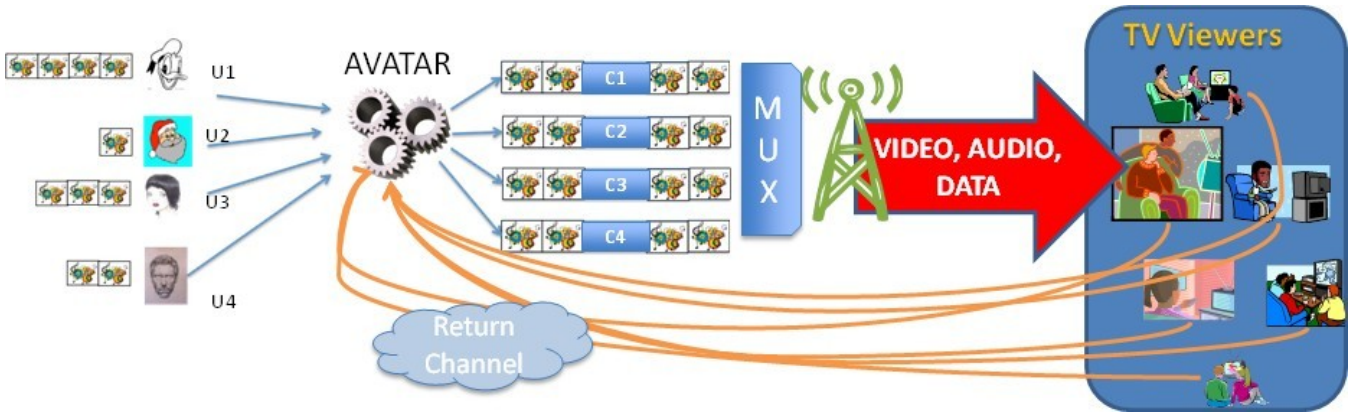

Figure 2 – Second scenario

IV. SECOND SCENARIO

In this new situation, illustrated in Figure 2, there is a permanent link between the households and the recommender system. The uploading of the content is the same as in the previous case. However, there are not any virtual user profiles like in the previous section. As users rate contents, their individual user profile is updated. Thus, the system has a complete set of profiles from the audience.

Besides, it is possible for the system to know the users that are viewing television in real time.

Using clustering techniques (k-means) the proposed system divides the real time audience in four subgroups. The users that belong to the same subgroup will have similar preferences. We cannot say in design time what will be the preferred genre for each group, since it is computed according to the people that is connected in every moment. Each subgroup will have a centroid that we associate with a virtual user profile that represents the part of the audience included in it. For each of the four virtual profiles a sequence of clips is recommended, building in real time the list of contents to be broadcasted through each of the four services available. In Figure 2 these services are named C1 to C4, standing for each one of the clusters in which the proposed system divides the audience. Thus, each service will transmit content that is of interest for each of the four subgroups recognized in the actual audience.

This segmentation solves the second of the disadvantages pointed out in the previous scenario.

The first disadvantage referred is related to the fact that the only tool the system has to know about the relevance of a new clip is from the metadata provided by the author. This is not enough to know if the content has good or bad artistic quality. To fix it, we have introduced a new resource in the proposed system. The system not only recommends according to the genre and other classifications, but also using other properties like cast, locations and so on. In this case we emphasize the weight of the "Author" property. So authors who uploaded clips that people liked in the past, will have better ranked clips and so they will have more chances to be broadcasted in a high audience period like Prime Time.

V. CONCLUSION

A new way to generate contents to Digital Television has been proposed. It is designed considering some necessities from developing countries. It provides more television signals with minimum costs. Besides, it is participative, since people upload content. Finally, the content is interesting for the audience since the use of recommender systems is contemplated in the system.

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