Volume 2 No. 7, July ISSN 2223-4985

International Journal of Information and Communication Technology Research

http://www.esjournals.org

A Survey of Personalized Television and Video Recommender Systems and Techniques

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ABSTRACT

The number of channels and genres offered by television and video service providers has increased and proliferated tremendously in recent years. This continuous increase is as a result of different factors such as preferences, interests, tastes and demographics of individuals who watch television and video. In order for television and video service providers to attract, retain and satisfy customers, they need to deliver substantive, lucrative, efficient and effective services through channels and genres that meet the interests, tastes and preferences of users/customers. Furthermore, users of television and videos usually watch their favourite channels and genres and as a result of information overload (too many channels and genres), they may miss an opportunity to watch an important program or use inappropriate time to search for their favourite channels and genres. Such Television and Video Devices/Services require systems and techniques that recommend television and video channels for users with respect to their interests, tastes, demographics and preferences. The main objective of this paper is to survey through exploration of literature and existing research, various researches undertaken in the scientific and practical area of personalized television and video recommender systems specifically from the perspective of types, architectures and applications. The paper also explores the challenges and future works proposed by some of the existing research surveyed and makes a recommendation.

Keywords: *Television (TV), Video, Personalized, Recommender Systems, Interests, Preferences, Users, Channels, Genres*

1. INTRODUCTION

The enormous growth of channels and applications of TV and video service providers has made watching TV and video more exciting amongst users. However due to this enormous growth there is the problem of information overload amongst users who watch TV and video. Most TV and video users have favourite channels and genres that they prefer to watch. Furthermore, it is also known that gender, age, culture, and social influences play a role in the kinds of information that people like [1]. As a result of demographic factors such as male, female, different ages and other interest and preference factors of users, personalization techniques and systems are required to help users watch programs, channels and videos of particular interests and tastes. For example, children below the age of eight 8 years are likely to be interested in watching cartoons and video games. Age groups between ten (10) years and twenty (20) years will have their own preferences of genres and adults above twenty (20) years will also have different interest and preferences in terms of TV/video channels and genres.

The meaning of information lies in the eyes of the beholder. All human beings perceive things differently. Users of TV and video usually want the most relevant and appealing channels. The user in this case is consuming data produced by others, such as content on television and online on YouTube[1] etc. [2]. Users will find TV and video watching more exciting if recommendations can be made for them either implicitly or explicitly. These personalized recommendations will be made based on the preference and interest as well as taste of users [1, 2]. Personalized recommender techniques and systems seek to solve issues of information overload of channels and genres so that users can watch their favourite channels and genres [1, 2].

Personalization has been explored from various angles in the literature. Recommender systems are widely in use for recommending all sorts of merchandise to individual consumers. There are a number of web sites that recommend music, movies, and restaurants among other products based on a user profile (www.launch.com online music, restaurant recommenders, movie recommenders, etc.) [2]. When designing content searching systems, it is important to present the summary that will be appealing to the user rather than have a single summary for all users [1, 2].

The main objective of this paper is to survey through exploration of literature and related work, some of the various researches conducted in the area of personalized TV and video Recommender techniques and systems. The rest of the paper is organized as follows: Section 2 describes the various recommender systems and techniques available according to literature and Section 3 discusses Open Research Issues in the area of personalized TV and video recommenders systems. Section 4 presents an Overview of the State-of-the-Art in the area of Personalized TV and Video Recommender Systems. A conclusion with recommendation is presented and discussed in Section 5.

2. RECOMMENDER SYSTEMS AND TECHNIQUES

There is a lot of research in the area of recommender systems dating back from the mid nineteen nineties (1990s). Recommender Systems are beneficial in areas such as e-commerce, education and entertainment. The widely accepted informal definition of a recommender system is: "Recommender systems are specific types of information filtering (IF) techniques that attempt to present

[1] *www.YouTube.com*

information about items (movies, music, books, news, images, web pages, etc.) that are likely to be the interest or preference of a user". Generally, recommender systems [3] and [4] cited by [1] are usually classified into the following categories:

- **Content-based Recommenders:** The user will be recommended items similar to the ones the user preferred in the past. These systems (also called Information Filtering (IF) systems) require a profile of user needs.

- **Collaborative or Social Recommenders:** The user will be recommended items that people with similar tastes and preferences liked in the past. In the Collaborative Filtering (CF) approach, the recommender system identifies users who share the same preferences (e.g. rating patterns) with the active user, and proposes items which the like-minded users favored (and the active user has not yet seen). Both methods present advantages and disadvantages and significant research effort has been devoted to hybrid recommendations methods that combine collaborative and content-based filtering exploiting the advantages of both methods [5], [6] and [7] cited by [1].

The more significant drawback of each of the above systems/techniques is precisely solved by using the other method.

On one hand, the problem of *overspecialization* of Content-based Recommender Systems (only very similar items to previous items consumed by the user are recommended) does not appear using collaborative filtering because this algorithm can recommend other items which the like-minded users rate as great value [1].

On the other hand, for a Collaborative Filtering Recommender System to work well, several users must evaluate each item; even then, new items cannot be recommended until some users have taken the time to evaluate them (*first-rater* problem). The system is therefore unable to generate semantic interconnections to these items and therefore they are never recommended [1].

Similarly, the *cold start* problem is caused by new users in the systems who have not submitted any ratings. Without any information about the user the system is not able to guess the user's preferences and generate recommendations until a few items have been rated [1].

Both problems (*first-rater* and *cold start*) can be solved by using Content-based Recommender Systems because they allow the user to encounter new content that has not been rated before since the system must be capable of matching the characteristics of an item against relevant features in the user's profile. In the same way, they permit the new user to find interesting contents [1].

3. OPEN RESEARCH ISSUES

TV and video services which are used by individuals of different preferences and interests for the purposes of entertainment, education, current affairs, documentaries, news etc. have grown tremendously in recent years.

For example, 97% of households in Germany possess a television set with an average usage of 220 minutes per day [8] cited by [9]. Therefore, it is not surprising that the satellite operator Astra holds up to 1700 TV channels just for the region of Germany [10] cited by [9].

Furthermore, DStv Ghana a subsidiary of Multichoice Africa offers subscribers a wide range of excellent entertainment with the following eleven (11) genres [11]:

- Movies
- Entertainment
- Lifestyle & Culture
- Sport
- Documentary
- Children
- Music
- Religion
- News & Commerce
- Specialist
- Audio & Radio

Within each genre there are many TV channels available for users. For example in the Movies genre, there are a minimum of five (5) channels consisting of M-Net, M-Net Movies I (MM1), M-Net Movies II (MM2), M-Net Stars and M-Net Action depending on the level of subscription [12].

All these examples of channels and genres constitute information overload to users of the TV service providers. As elaborated in Section 1, TV and video service provides need to deliver and facilitate appropriate, effective and efficient recommender techniques to allow users watch TV and videos based on their interests, tastes and preferences. To overcome the problems and disadvantages of information overload involving genres and channels of TVs/video services, researchers have to adopt a suitable approach of using either Collaborative Filtering, Content-Based or Hybrid Recommender (Content-Based + Collaborative Filtering) Systems to solve these problems.

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4. AN OVERVIEW OF THE STATE-OF-THE-ART: PERSONALIZED TV AND VIDEO RECOMMENDER SYSTEMS

4.1 Survey of Some Existing Applications and Services

Recommender systems as discussed above are available in application and service area of TV and video, where by TV and video contents are recommended to users. In this section, a brief description of some related works of existing applications and services conducted by researchers in the scientific and practical area of personalized TV and video recommender systems are presented.

In (*Martínez et al.., 2009)* [1] discussions are presented on the fact that people are exposed to an information overload, because of the expansion of digital networks and TV devices and the rapid increase of the number of channels due to the presence of several hundreds of alternative programs to watch. In this context, personalization is achieved with the employment of algorithms and data collection schemes that predict and recommend to television viewers content that match their interests and/or needs.

Martínez et al., (2009) [1] introduced ***queveo.tv***: a personalized TV program recommendation system. Their proposed hybrid approach (combining content-filtering techniques with those based on collaborative filtering) also provides all typical advantages of any social network as comments, tagging, ratings, etc. The web 2.0 application (***queveo.tv***) in (*Martínez et al., 2009)* [1] has been devised to enormously simplify the task of selecting what program to watch on TV. The overview of the recommender framework in (*Martínez et al.., 2009)* [1] is depicted in figure 1.

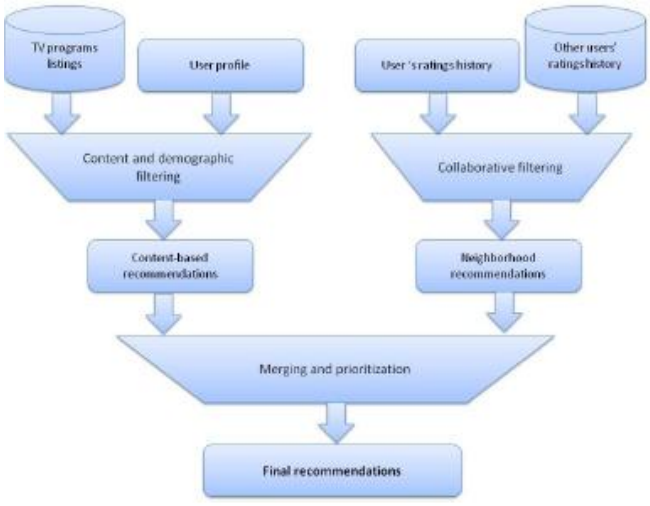

Figure 1: Overview of Recommender Framework
Source: (*Martinez et al.., 2009)* [1]

Venkatesh et al., (2008) [2] emphasize how recent growth in broadband access and proliferation of small personal devices that capture images and videos has led to explosive growth of multimedia content available everywhere from personal disks to the Web. While digital media capture and upload has become nearly universal with newer device technology, there is still a need for better tools and technologies to search large collections of multimedia data and to find and deliver the right content to a user according to his/her current needs and preferences. A renewed focus on the subjective dimension in the multimedia lifecycle, from creation, distribution, to delivery and consumption, is required to address this need beyond what is feasible today. Integration of the subjective aspects of the media itself it's affective, perceptual, and physiological potential (both intended and achieved), together with those of the users themselves, will allow personalizing the content access, beyond today's facility. This integration, transforming the traditional Multimedia Information Retrieval (MIR) indexes to more effectively answer specific user needs, will allow a richer degree of personalization predicated on user intention and mode of interaction, relationship to the producer, content of the media, and their history and lifestyle. In (*Venkatesh et al., 2008*) [2], the researchers/authors identify the challenges in achieving this integration, current approaches to interpreting content creation processes, to user modeling and profiling, and to personalized content selection. Details for future directions are also presented and discussed in (*Venkatesh et al., 2008*) [2].

Delivery of personalized multimedia content is an important challenge for versatile video podcast environments. *Sánchez-Nielsen, et al., (2007)* [13] focus on the opportunities given by MPEG-7 metadata standard for content delivery in terms of user preferences when podcasting technology is used. By means of MPEG-7, multimedia content can be described at several levels of granularity and abstraction. *Sánchez-Nielsen, et al., (2007)* [13] propose the use of this description in order to produce and publish personalized information according to user's demand in podcast environments and to compute in a dynamic way the different feeds of the podcast information system when it is demanded by users. *Sánchez-Nielsen, et al., (2007)* [13] describe this approach for the motivating scenario of audiovisual content for legislative assemblies.

Engelbert et al. (2011) [9] emphasise that the number of receivable TV channels has highly increased in recent years and handling the enormous offer of TV content could be a challenge for the users in case of selecting the most interesting program. Furthermore, most users only focus on their favorite TV channels. That's the reason why content on other channels won't be recognized. For this problem assistive systems and tools are desirable to support in selecting the most appealing content with respect to the user's interests. The research group Next Generation PVR (NG-PVR) (*Engelbert et al. 2011)* [9] extended a personal video recorder (PVR) with a generic recommendation system based on a Bayesian classifier and adapted it for the

use in the application area of television. The system analyzes the user's TV watching behavior to present new choices of content. So the system is able to generate personalized TV program recommendations. The content is stored on an internal hard disc drive where it is recorded for the user to watch. *Engelbert et al. (2011)* [9] presents the current state of development by introducing the system's architecture and implemented recommendation mechanisms.

The system architecture used in (*Engelbert et al. 2011)* [9] is depicted below in figures 2 and 3.

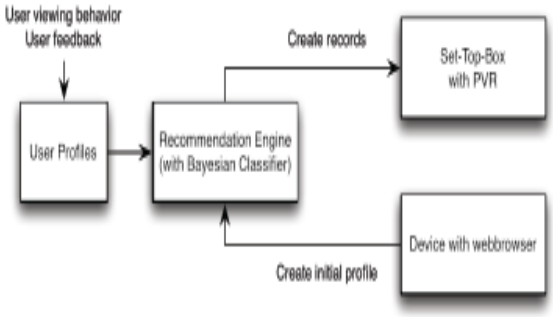

Figure 2: Architecture of Personal Video Recorder (PVR) Implementation
Source: (*Engelbert et al. 2011)* [9]

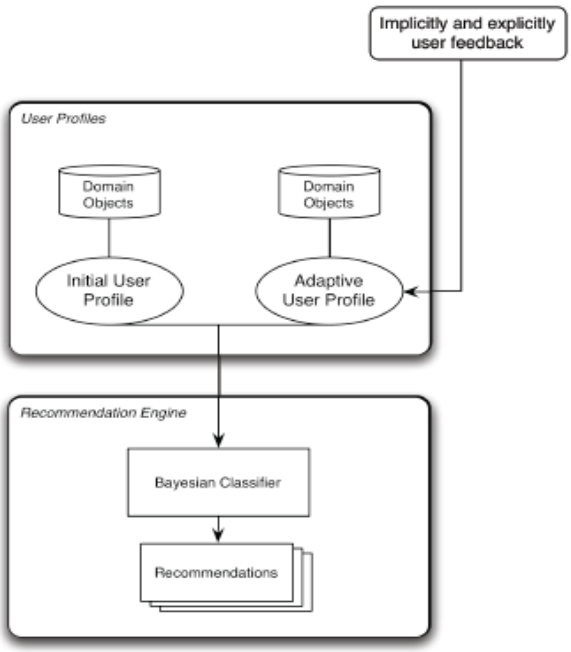

Figure 3: Generic Architectural Overview
Source: (*Engelbert et al. 2011)* [9]

Ubrella et al., (2009) [14] presented algorithms and techniques to generate recommendations for Digital Video Broadcast (DVB) content. The developed recommendation engine in (*Ubrella et al., 2009)* [14] uses metadata which are delivered by the DVB transport stream and the Service Information. The creation of user profiles, which contains the preferences of an individual user, is described. Personalization strategies, to filter the interesting contents for each user, were shown. Furthermore new developed and firstly presented algorithms to generate recommendations for DVB content are listed and described in (*Ubrella et al., 2009)* [14]. A PPG (Personal Program Guide), which has been developed to visualize the recommendations, is also shown in (*Ubrella et al., 2009)* [14]. Several tests show the usefulness of the developed recommendation scheme in (*Ubrella et al., 2009)* [14].

Figure 4 shows the Ontology Genres used in the Recommendation Index in (*Ubrella et al., 2009)* [14].

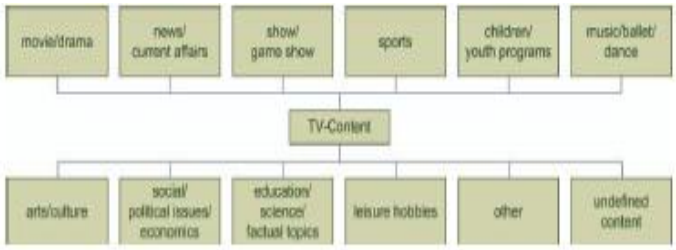

Figure 4: Ontology Genre in Recommendation Index
Source: (*Ubrella et al., 2009)* [14]

Mobile TV provides multimedia contents to the user through wireless communication. In such a scenario, the personalized recommendation system allows the users to easily select the contents that need to be accessed. *Yong et al., (2011)* [15] propose a personalized recommendation scheme which considers the activities of the user at runtime and the information on the environment around the user. It allows efficient operation in mobile device, and interoperability between the TV multimedia metadata and ontology. The accuracy of the proposed scheme in (*Yong et al., 2011)* [15] is evaluated by an experiment, which reveals a significant improvement compared to the existing schemes.

Figure 5 shows the structure of the proposed system in (*Yong et al., 2011)* [15] is shown below.

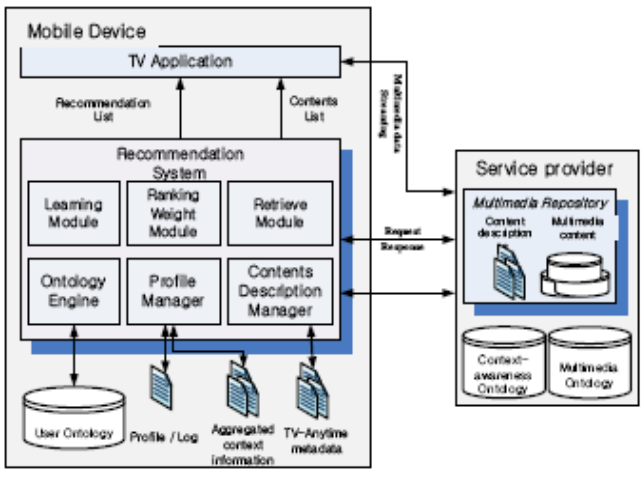

Figure 5: Ontology Genre in Recommendation Index
Source: (*Yong et al., 2011)* [15]

Boutemedjet et al., (2008) [16] elaborate on how existing recommender systems provide an elegant solution to the information overload in current digital libraries such as the Internet Archive. Nowadays, the sensors that capture the user's contextual information such as the location and time are becoming available and have raised a need to personalize recommendations for each user according to his/her changing needs in different contexts. In addition, visual documents have richer textual and visual information that was not exploited by existing recommender systems. In (*Boutemedjet et al., 2008*) [16], a new framework for context-aware recommendation of visual documents by modeling the user needs, the context and also the visual document collection together in a unified model is proposed.

The user's needs for diversified recommendations are also addressed in (*Boutemedjet et al., 2008)* [16]. The pilot study in (*Boutemedjet et al., 2008*) [16] showed the merits of the approach in using content based image retrieval.

TiVo, described in *(Ali and Stam, 2004)* [17] is one of the popular TV Recommendation Systems. TiVo is a commercial Set-Top-Box with an integrated recommendation service. TiVo uses a combination of a content-based Bayesian algorithm and a collaborative-filtering approach. Recommendations in TiVo are mainly generated from the collaborative approach, where item-to-item (e.g. movie-to-movie) relations are calculated from a user's feedback for TV content. To accomplish this task, TiVo uses a database with 100 million of user ratings of up to 30,000 TV shows and movies. A large number of active users are needed for the collaborative approach in TiVo. The Bayesian algorithm in the TiVo system is used to overcome the problem for new shows without any user feedback *(Ali and Stam, 2004)* [17].

Digital multimedia broadcasting service has been at the center of developing issues in mobile environment. In contrast to traditional multimedia broadcasting systems, mobile devices have limit of information handling capacity. In order to solve the problem, *Park et al., (2006)* [18] presented a personalized channel recommendation system at client side in mobile environment. The system in (*Park et al., 2006)* [18] includes four modules: client manager agent, monitoring agent, data preparation agent and recommendation agent. Within the recommendation agent, *Park et al., (2006)* [18] develop a recommendation algorithm using users' preference transitions for the channels. Also, *Park et al., (2006)* [18] design and implement the prototype system on the Wireless Internet Platform for Interoperability. In the experiment, *Park et al., (2006)* [18] compare their proposed algorithm with a conventional method. The experimental results in (*Park et al., 2006)* [18] show that the proposed recommendation system can provide better performance than the conventional method.

Figure 6 shows the Overall architecture of system for providing personalized channel recommendation in mobile environment in *Park et al., (2006)* [18].

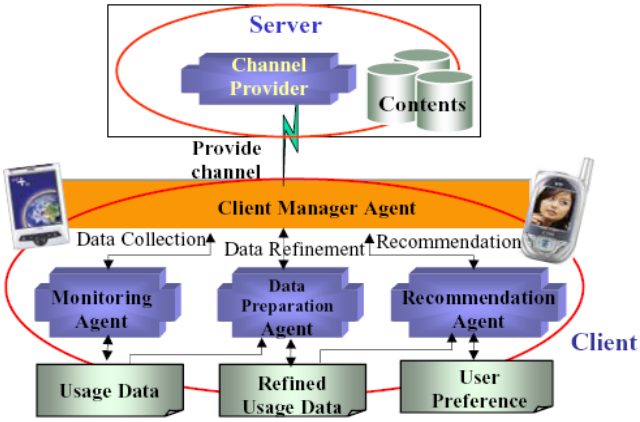

Figure 6: Overall Architecture of System for Providing Personalized Channel Recommendation in Mobile Environment
Source: (*Park et al., 2006)* [18]

In *(Lee et al., 2009)* [19] discussions are presented on how the emergence of networked mobile computing devices creates many opportunities for consumption of multimedia content on the move. However, such mobile devices have inherent resource constraints: low network bandwidth, small screen size, limited input methods and low commitment viewing. To facilitate access to news video on mobile devices, a prototype system in *(Lee et al., 2009)* [19] has been implemented on a HTC Dream (T-Mobile G1) mobile phone at 320x240 resolution, demonstrating an "adaptive TV-channel" like mixed-initiative interface used to solicit user relevance feedback.

Combined with network prefetching, a cognitively palatable stream of videos and a seamless lower-latency user experience is created in *(Lee et al., 2009)* [19].

4.2 Challenges and Future Work of Existing Research

Some future works in relation to this survey paper are as follows:

Martínez et al., (2009) [1] proposed to make use of recommendations of opinion leaders. Opinion leaders divide users into two distinct groups: a large majority of consumers that contribute only a little to a mass-average and a group of self-selected leaders that are willing to spend more effort on the system for getting social or monetary reward.

Martínez et al., (2009) [1] discuss how the growing presence of mobile devices such as PDAs and smartphones, along with advances in wireless network communication technologies, have created new opportunities for making the applications and services available on these hosting devices more intelligent and supportive to the user. Therefore (*Martínez et al., 2009*) [1] also plan in future to extend the

service to be offered to handheld devices and interactive digital TV. Once the profile is filled in using the web interface, it is also valuable that users can query the recommendations sitting in their living room by using their PDA, cellular phone or set-top-box with internet access.

Currently the Bayesian classifier works as a web based application with the underlying system architecture shown in (*Engelbert et al. 2011)* [9]. The next step proposed by (*Engelbert et al. 2011)* [9] will be to connect the developed software with the PVR system to transfer recommendations and start the automatic recording process. To corroborate this, (*Engelbert et al. 2011)* [9] have plans to keep the software running on a web server where a web service provides connection to the PVR system. The work on the evaluation scenario described in (*Engelbert et al. 2011)* [9] isn't finished as of now and is ongoing for the future.

Experiments in *Yong et al., (2011)* [15] recalls that the value of λ reflects the weights of common concept, UTC (x). With $\lambda = 0.7$, the precision is better than $\lambda = 0.3$. As a future work, *Yong et al., 2011* [15] stated that it is necessary to calculate the value of λ considering various factors of the environment and user query for the recommendation.

Sánchez-Nielsen, et al., (2007) [13] proposed future work that will deal with the automatic generation of textual descriptions for video content based on visual feature and temporal and semantic relations between concepts.

5. CONCLUSION & RECOMMENDATION

The tremendous growth of TV and video devices coupled with enormous TV/video channels and genres has introduced information overload to TV and video users. This paper presented a survey of some of the researches conducted in the scientific and practical area of personalized TV and video recommender systems and techniques. Personalized TV and video recommender systems and techniques are used to solve information overload (too many channels and genres) problems by filtering and recommending channels and genres with respect to TV/video user preference, interest, taste and demography.

Some future work in the area of personalized TV and video recommender systems of this survey paper have been proposed in Section 4.2. This paper recommends researchers to research more in the area of personalized TV and video recommender systems to improve and innovate systems and techniques that will eliminate and reduce information overload (too many channels and genres) of TV and video users.

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