Personalized Recommendation Schemes for DTV Channel Selectors

Hyejeong Lee, Soyoon Lee, Heekyung Kim, and Hyokyung Bahn

Abstract — *The emergence of new TV media such as digital cable and satellite has diversified TV contents. This makes the task of finding one's favorite contents among hundreds of TV channels a time consuming job. To relieve this channel selection overhead, this paper presents personalized recommendation schemes for DTV channel selectors. The proposed recommendation schemes analyze each person's previous watching behavior in terms of recency and frequency, and then utilize this information in the control of the top-down channel selector. Simulation studies show that the proposed schemes reduce the seek cost of the DTV channel selector by up to 62.8% for the trace set we considered.* [1]

Index Terms — recommendation, DTV, channel selector, MRS (most recently selected), MFS (most frequently selected).

I. Introduction

With the recent explosion of TV contents and the advances in digital cable and satellite technologies, hundreds of TV channels have emerged. This great quantity of TV channels has made the task of finding one's preference difficult. As a result, TV viewers waste plenty of time in browsing contents or just watch a very limited number of channels. Due to such an exhausting channel selection overhead, users need a specialized channel selection system that provides the function of recommending appropriate channels.

Moreover, the advent of digital broadcast systems and a new class of consumer electronic devices such as Personal Video Recorders (PVR) have changed how people watch TV. PVR is a device that is similar to a VCR but records television data in a digital format on disks. PVR enables users to navigate lots of TV show schedules through the Electrical Program Guide (EPG) that is an on-screen TV program guide. Using a remote control, EPG users can navigate, select, and discover contents by the time, title, channel, and genre [1].

Generally, PVR users tend to store their favorite TV programs and then watch them whenever they want instead of watching a live broadcast. Therefore, PVR users should select a small set of TV shows to store from hundreds of channels [2]. Thus, it is also important to provide an efficient TV channel recommender for PVR users according to user preferences. In particular, the channel recommender should provide users to find their desired contents quickly and easily, and at the same time it should filter out unwanted programs.

In this paper, we propose two dynamic channel recommendation schemes for DTV channel selectors. Our new schemes analyze user's preference of channels from the previous behaviors and then recommend channels that could minimize the scanning time of finding the desired channel. To this end, the schemes create a priority list of the all TV channels according to the estimated user's preferences. Then, whenever a user pushes the channel selection button, the schemes recommend the channels by the order of the priority list.

The first scheme, namely the Most Recently Selected (MRS) scheme, shows the most recently watched channel preferentially when the user pushes the recommendation button. This is based on temporal locality, which means that a TV channel selected more recently will more likely be selected again in the near future. The second scheme, namely the Most Frequently Selected (MFS) scheme, on the other hand, recommends the channel that the user watched most frequently when the user pushes the recommendation button first. MFS is based on the property that a TV channel selected more frequently will more likely be selected again in the near future. Through trace-driven simulations with various experimental environments, we show that the proposed recommendation schemes perform better than conventional channel selector systems in terms of the scanning time to find the desired channel. Specifically, when the number of TV channels is 150, the performance improvement of the MFS scheme against the conventional channel selector system is up to 62.8%.

The remainder of this paper is organized as follows. Section II presents related works on the TV channel recommendation

Fig. 1. Various TV channels and their contents. As New TV media such as digital cable and satellite have diversified TV channels, the task of finding one's favorite contents is becoming an increasingly time consuming job.

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The authors are with the Department of Computer Science and Engineering, Ewha University, Seoul, Korea. Hyokyung Bahn is the corresponding author (email: bahn@ewha.ac.kr)

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systems. Section III presents the new channel recommendation schemes, and Section IV describes the performance results of the proposed schemes against conventional channel selection systems. Finally, Section V concludes the paper.

II. Related Works

Many researches have been performed in the area of TV content recommendation systems. Das and Horst introduced a TV advisor that generates and shows TV channels in the recommendation list [3]. In their system, individual users initialize the channel recommendation list according to their interests in order to get high quality recommendations. Though this technique is easy to implement in a set-top box, it has some limitations in that the recommendation is predetermined and hence users should update new intriguing TV channels into the recommendation system as time progresses.

Cotter and Smyth presented the PTV system that employs a mixture of case-based reasoning and collaborative filtering to generate channel recommendations [4]. In their system, users initially register their favorite channels, genre, and viewing times similar to Das and Horst's system. However, unlike previous systems, the PTV recommender dynamically predicts users' preferences based on case-based reasoning and collaborative filtering. Case-based reasoning analyzes the input of program requests that a user liked in the past and then recommends contents based on this analysis. Collaborative filtering recommends TV contents that other users, having characteristics similar to a given user's profile, liked. It is possible to use other users' profiles because PTV is Internet based. This technique may incur privacy problems since information about a user's likes and dislikes is used to make recommendations to other users [2][4].

Ardissono et al. proposed the personalized EPG (Electrical Program Guides) that employs an agent-based system designed for the set-top box operations [5]. The system consists of three user modeling modules that are the explicit preferences expert, the stereotypical expert, and the dynamic expert. The explicit preferences expert deals with preferences declared by users during the initial setup. The stereotypical expert classifies individual users into one of the lifestyle (stereotypical) groups based on the users' personal data known to the system and the explicit preferences stated by the users. The dynamic expert analyzes users' watching behaviors, and builds and adapts the model of the users based on the analysis. These three modules cooperate to prepare the final recommendations.

III. Personalized Recommendation Schemes for DTV Channel Selectors

This section presents new personalized recommendation schemes for DTV channel selectors. The recommendation system of a DTV plays an intermediate role between the channel selector of the TV and the main TV system. Users can make a request to the channel selector using two types of buttons, namely the top-down buttons and the numerical buttons. The top-down buttons are used for the sequential search of channels and the numerical buttons are used for the direct selection of a certain channel. In our recommendation schemes, when a user pushes the top-down buttons, the channel selector displays channels not in the sequential order but in the user's preference order maintained by the channel recommendation system. The top button is used for searching channels from the top in the recommendation list, and the bottom button is used for the backward scanning of the visited channels during the scanning time. From now on, we will refer to the top button as the channel recommendation button in this paper.

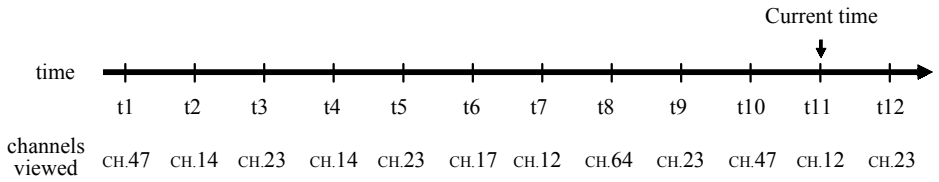
Our new schemes analyze user's preference of channels and then recommend the channels that could maximize the satisfaction of the user. A user will feel great satisfaction when the recommendation system shows the desired TV channel without much time of scanning. In sum, the aims of our channel recommendation systems are the reduction of the seek time in relation to channel selection and the increase of users' satisfaction from adaptive recommendation through understanding each user's preferences.

The channel recommendation system exploits two types of user preferences, namely the explicit preferences and the implicit preferences. Explicit preferences are that a user specifies one's interests to the channel recommendation system directly. Therefore, user's preferences can be reflected immediately to the recommendation system. On the contrary, implicit preferences are based on the unobtrusive observation of user's viewing habits. Unlike explicit preferences, the system should continuously monitor the user's behavior to obtain the user's preferences. Using implicit preferences can reduce the amount of work required to users who want minimal interaction with the recommender and enable the recommender to adapt the changes of user's preferences properly.

We categorize our recommendation schemes into two types, based on how the schemes exploit the implicit preferences of users. The first proposed scheme is the Most Recently Selected (MRS) TV channel recommendation scheme. In this scheme, the recommender shows the user's most recently watched channel preferentially. This is based on temporal locality, which means that TV channels selected more recently will more likely be selected again in the near future. In this scheme, the channel recommendation system maintains the list data structure which contains the information of user's channel selection history in the recency order. If a user selects a TV channel and watches the channel for a specific period of time, then the channel has the highest priority and becomes the head of the list. The specific period of time here, can be set up by the system or the user beforehand. When the user pushes the channel recommendation button, the MRS scheme shows channels from the head of the prioritized list.

The Most Frequently Selected (MFS) TV channel recommendation scheme, the second proposed scheme, shows the most frequently watched channel preferentially. The MFS scheme considers TV channels with a large number of view counts as active channels. The MFS scheme is based on the property that TV channels with larger view counts will more

(a) An example of TV channels and their contents



(b) Channels viewed by a user as time progresses.

	Seek sequence	Seek distances
Conventional scheme	CH.12 → CH.14 → CH.17 → CH.23	3
MRS scheme	CH.12 → CH.47 → CH.23	2
MFS scheme	CH.12 → CH.23	1

(c) Seek sequences and the seek distances of the three schemes as the time becomes t12.

Fig. 2. An example of the MRS (Most Recently Selected) and MFS (Most Frequently Selected) schemes.

likely be selected again in the near future. In this scheme, all TV channels are basically sorted by user's view counts and then the channels are recommended from the largest view count.

Fig. 2 shows an example of the MRS and MFS schemes compared with the conventional channel selection scheme that recommends TV channels in the numerical order and does not consider user's preferences. In this simple example, there exist six channels and a user has watched these channels in the sequence as shown in Fig. 2(b). The time in the figure means the logical time that increases by one whenever the user operates the channel selector to watch a different channel.

Suppose that the selected channel at time t11 is CH.12 and the user pushes the recommendation button to find CH.23. In the case of the conventional scheme, the user should flick through the channels in the order of CH.14 and CH.17, and then find CH.23 after all. In the MRS scheme, however, the user will just visit CH.47 and then find CH.23. Thus, the number of seek is reduced by 1 when compared with the conventional scheme. In the MFS scheme, because CH.23 is the most frequently selected channel, the user can find the channel with only one seek.

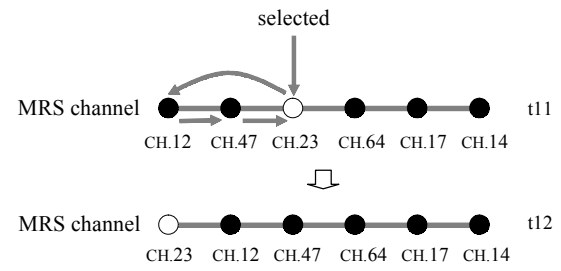
The priority list maintained by the MRS and MFS schemes are shown in Fig. 3(a) and Fig. 3(b), respectively. The two horizontal lists depict the state when the time is t11 and t12, respectively. In the MRS scheme, since CH.23 is the most recently watched channel at time t12, it moves to the head of the priority list and the list is rearranged. In the case of the MFS scheme, the view count of CH.23 is increased by one and then the position of this channel in the list is rearranged if necessary. Since the relative ordering of frequency counts does not change in this case, the locations of the channels in the list do not change.

When the channel recommendation system makes use of the observation report of a user's previous behaviors, inadequate information may be included. For example, skipped channels may be included in the priority list during the search operations. The channel recommendation system can filter out these channels when the staying time at a channel is not more than a specific period of time. In order to remove such noise information, MRS and MFS set up the threshold time. If the staying time at a channel is more than the threshold time, it is included in the user's preference information. Otherwise, the channel is just considered as a skipped channel and filtered out.

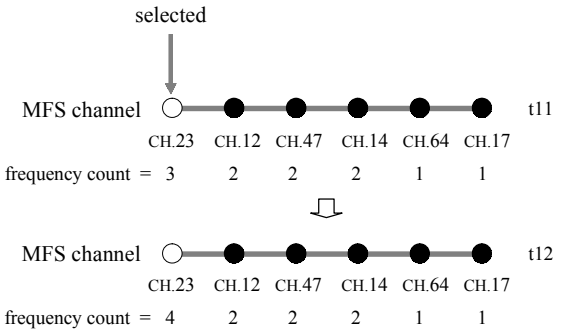
The proposed recommend schemes in this paper uses top-down buttons for the quick search of desired channels. In the case of the conventional channel selection scheme, the user will search almost a half of the whole channels to find the desired program in average cases. However, hot channels may be selected directly by the numerical buttons since users usually remember a certain number of their favorite channels. However, the number of channels that can be memorized is very limited. Furthermore, even they remember their favorite channels, users usually search the channels by the top-down buttons. Fig. 4 shows an experimental environment of the channel selector for the proposed channel recommendation system.

IV. Experimental Results

To assess the effectiveness of the proposed channel recommendation schemes, we have performed simulation



(a) Priority list maintained by the MRS scheme.



(b) Priority list maintained by the MFS scheme.

Fig. 3. The list data structure for the MRS and MFS schemes.

experiments with synthetically-generated traces. The number of requested channels in the traces is 10,000 and the number of distinct channels range from 10 to 150. Popularity of the channels is followed by the Zipf distribution which has an ability to represent the skewed popularity distribution of objects [6]. In our experiments, the request probability P_i of the i-th popular channel is determined by the Zipf distribution and calculated by Equation (1).

$$P_i = \frac{(1/i)^{\theta}}{\sum_{i=1}^{n}(1/i)^{\theta}} \quad (1)$$

where n is the total number of distinct channels and θ ($0 \le \theta \le 1$) is the Zipf parameter that determines the degree of popularity skew. When θ is 0, all channels are equally popular. As the value of θ increases, the popularity of channels is increasingly skewed, and finally when it becomes 1, the popularity is most skewed.

We compared the MRS (Most Recently Selected) and the MFS (Most Frequently Selected) recommendation schemes with the conventional channel selection scheme that recommends TV channels in the numerical order and does not consider user's preferences. Fig. 5 shows the average channel seek cost of the three schemes as a function of the Zipf parameter. The seek cost means the flick counts of the channel selector button to find the requested channel. When the Zipf parameter θ is equal to 0, the three graphs merge to a single point. This is because the Zipf parameter value of 0 implies all

Fig. 4. Experimental environment of the channel selector for the proposed recommendation system.

the channels are equally requested which means the distribution is reduced to random. This is an unrealistic scenario and actually there is no way to improve the performances under this assumption. As the value of Zipf parameter θ increases, the performance gap between the conventional scheme and the two proposed schemes becomes

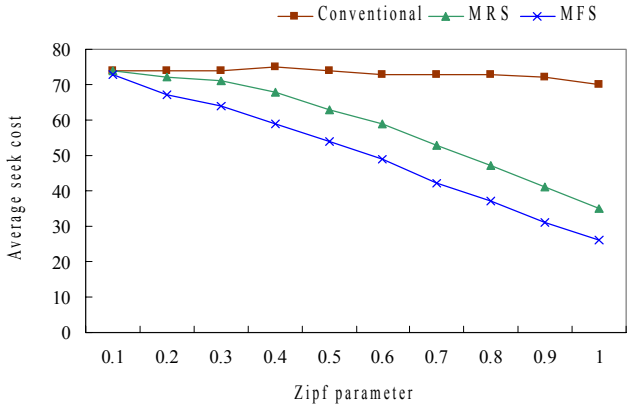


Fig. 5. The average seek cost of the MRS, MFS, and conventional schemes as a function of the Zipf parameter.

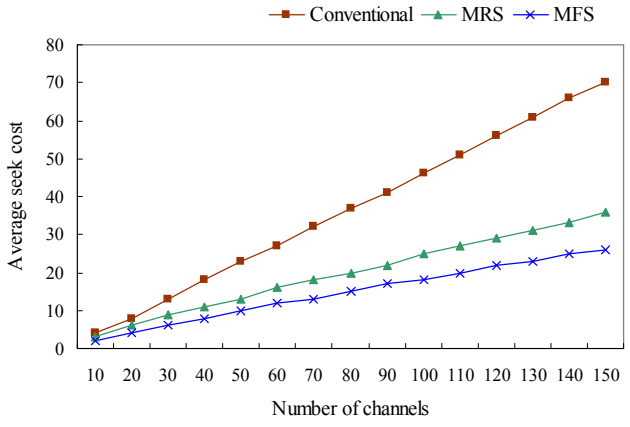


Fig. 6. The average seek cost of the MRS, MFS, and conventional schemes as the number of channels increases.

wider. Specifically, the performance improvement of the MFS scheme against the conventional scheme is up to 62.8% in terms of the average seek cost.

Fig. 6 shows the average seek cost of the three schemes as the number of TV channels increases. As can be seen, the proposed schemes outperform the conventional scheme by a large margin when the number of channels is sufficiently large. Specifically, when the number of TV channels is 150, the conventional scheme requires average flick counts of 70 in finding the requested channel while MFS requires just 25. MFS consistently shows better performances than MRS. This implies that the frequency count of user's past behavior is more significant factor than the recently viewed time in our experimental environments.

V. CONCLUSIONS

In this paper, we presented two channel recommendation schemes, namely, MRS and MFS, for DTV channel selectors. Our new schemes analyze user's preference of channels and then recommend the channels that could minimize the scanning time of finding the requested channel. MRS shows the most recently watched channel preferentially when the user pushes the recommendation button. This is based on temporal locality, which means that a more recently selected channel will more likely be selected again in the near future. MFS, on the other hand, recommends the most frequently watched channel when the user pushes the recommendation button first. MFS is based on the property that a TV channel having a larger view count will more likely be selected again in the near future. Through trace-driven simulation with various experimental environments, we showed that the proposed recommendation schemes perform better than conventional channel selector systems in terms of the scanning time to find the requested channel. Specifically, when the number of TV channels is 150, the performance improvement of the MFS scheme against the conventional channel selector system is up to 62.8%.

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Hyejeong Lee received the BS degree in computer science from Ewha University, Seoul, in Feb. 2006. She is currently an MS candidate in computer science and engineering, Ewha University, Seoul. Her research interests include system security, operating systems, distributed systems, low power systems, intelligent storage systems, system optimization, and ubiquitous computing.

Soyoon Lee received the BS and MS degrees in computer science from Ewha University, Seoul, in 2004 and 2006, respectively. She is currently a PhD candidate in computer science and engineering, Ewha University, Seoul. Her research interests include scheduling algorithms for group elevator control systems and software technologies for storage systems.

Heekyung Kim received the BS degree in computer science from Ewha University, Seoul, in Feb. 2005. She is currently an MS candidate in computer science and engineering, Ewha University, Seoul. Her research interests include operating systems, low power systems, Web technologies, reference behavior modeling, genetic algorithms, and distributed systems.

Hyokyung Bahn received the BS, MS, and PhD degrees in computer science from Seoul National University, in 1997, 1999, and 2002, respectively. He is currently an assistant professor of computer science and engineering at Ewha University, Seoul. His research interests include operating systems, caching algorithms, Web technologies, reference behavior modeling, genetic algorithms, and ubiquitous computing. Dr. Bahn is a member of the IEEE Computer Society, the IEICE, and the Korea Information Science Society.