Media space navigator: efficient access to video content on IPTV portals

The growing amount of content available on IPTV offers creates a significant navigation challenge. The media Space Navigator presented in this article combines data from different sources (video on demand, live broadcast) into a unified graph structure via similarity metrics. An innovative GUI enables users to casually browse and interact with this data structure via a standard remote control, letting them navigate the most relevant neighbourhood of a stored movie or life broadcast.

Introduction

With the introduction of IPTV services, today broadcast and on demand services may be offered seamlessly. The growing amount of content creates a significant navigation challenge for the user that we try to resolve by providing a uniform way to access both services simultaneously.

The Media Space Navigator combines entries from Video on Demand sources with data about live shows from EPG feed into a unified graph structure via similarity metrics. Users can browse the graph via an interface that has been designed for casual browsing with a remote control: for each entry, it provides a ranked view of the most relevant neighbours, which are accessible using cursor buttons. By selecting an entry, users can either select a node, or directly jump to the content (either the broadcast channel or a payment dialog to access a stored movie). The approach taken differs significantly from common graph-based interfaces that are now popular in web communities and computer visualisation, as the classical input modality – the computer mouse – is unavailable in this setting. For this reason, we have designed a layout and command set for the user interface that maps naturally to the cursor keys found on set-top box remote controls.

The similarity measure is computed in a hybrid approach by fusing different meta-data domains (film genre, actors, etc.), graph distance metrics and user preferences that can be entered casually during navigation: rating entries with one to three plusses influences genre and actor weights in the similarity calculation. The weights are determined by counting the number of entries per category and per person; while we use the number of actor occurrences as a popularity indicator, we use the inverse category size as an indicator for the generality of a topic. While browsing, users can rate entries, which further influences the category and actor link weights.

The feedback from an initial set of test users gathered during a three-day multimedia exhibition showed that the presented approach is easily understood and is valuable extension of traditional browsing mechanisms that enforce a more static ordering of contents in genre/sub-genre lists.

Motivation

With the introduction of IPTV services, today broadcast and on demand services may be offered seamlessly. In the current navigation scheme, once one of the two services is selected via the main portal, two different types of navigation are implemented for the two domains; a tabular EPG in the broadcast domain and static linear navigation structure for the VOD content. As the number of broadcast channels increases and the VoD library grows significantly, the searches for the desired movie may become long and tiring, whereas the motivation of the user decreases.

A way to support the user in finding his movie, and to speed things up, is to include contextual information about movies into the search, like linking together movies of the same genre or with the same actors. An additional part would be to include user preferences and context into the search. This means to prefer search results where the genre or the actors are to the users liking.

The system consists of two components: The backend analyses video meta-data gathered from different sources and user preferences to create a similarity graph, linking all entries. The frontend enables navigation by visualising a suitable subset of this graph.
Frontend

The Frontend application enables navigation of the similarity graph is intended for use on set-top boxes. As they use IR remote controls as user input, we have adapted the navigation principle to arrow keys and the OK button, in contrast to PC-based graph navigation mechanisms (Herman et. al. provide a nice overview), which rely on mouse input.

Fig. 1 shows the frontend with the most important features: the starting entry is located in the centre, surrounded by up to eight of the most relevant neighbours, entries coming from the video on demand (VoD) data set or the electronic program guide (EPG). The relevance of a movie item is mapped to a colour range between green (most relevant) and blue (least relevant). Each entry is displayed with its preview icon, movie title and the linking genre or actor; in addition EPG data is marked with a green border around the movie item.

Besides the graph a detail area on the right side provides information about the selected item like actors, creators and plot summary. For EPG entries this is enriched with information about start time and date as well as the broadcast channel.

When the user selects an item by pressing the OK button, this movie is centered and the most relevant neighbors are displayed. Pressing the OK button on a centered item leads to the broadcast channel for EPG items and for VoD items the payment dialog is opened. After insertion of the PIN the VOD movie is started.

Backend

Delivering the necessary information to the frontend, the functionality of the backend is depicted in figure 2. Starting from the top different data sources are read into a data pool. This way electronic program guide (EPG) data and video on demand (VoD) data can be handled in a uniform way in following processing stages. The metadata about movie entries is contained in XML files where the format for EPG entries is different to the format of VOD entries. Therefore it is necessary to convert entries from the two data sources to an object format that can be handled the same way in succeeding processing stages.

The categories an entry belongs to and the persons that appear in the movie are extracted too. They are used for linking entries together in the upcoming stage. If for example a person appears in two entries they are potential candidates for linking over this person. All existing categories and persons are extracted and the frequencies of occurrence are calculated. These serve as the weights for an initial linkage. All the data gathered until now is kept in a Data Pool that is the central structure for all subsequent user queries. Two entries can be linked by more than one relation. This happens for example if two entries belong to the same categories and the same actors appear in both entries. This is often the case for series or sequels of movies.

Initial weights are determined by summing up the number of entries within a category or the number of entries a person appears in. This category or person weight is then taken to give the initial connection weight between two entries linked over this category or person. Then the inverse weight sum is taken which means that categories or persons with a lower weight have higher importance for linking. This is because for example categories with a high weight are too general to give a reliable picture about what is tightly related and what is not. This is caused by the metadata as for example a lot of entries are tagged with the category ‘movie’ where at least two third of the whole database will fall into. It is clear that a more meaningful link description is desired that substantiates the relation between two entries at a more concrete level. Therefore categories with many entries shall be considered only if more special categories do not result in enough items in the search of neighbors for an entry. The Graph Generator is used in the next step by the Query Engine to process user requests received from the frontend. It uses the Data Pool to access the entry items and creates a list of entries that are linked by categories and persons. The graph generator applies the set filters that reject items that do not meet the specified filter criteria.
As the frontend displays the central movie item surrounded by the eight most prominent neighbors it is obvious that eight related entries must be found. Under normal conditions much more than eight related items will be found for an entry due to the vast amount of data items and the first eight will be returned, as they are the most important ones. In some cases when an item lies in a very special category it is possible that less than eight neighbors are found. In this case the actually found entries are returned. A possibility would be to use the empty slots to take some general movie items that should be specially advertised like new movies that were inserted in the database recently.

If a user likes an item more than others he/she is able to rate an entry on a scale from one to three (with one being the lowest and three being the highest rate). When the user sets the maximum rating to, for example, an action movie, this leads to a higher ranking of all items in the action category which again promotes action movies in subsequent queries of this user. Additional features include an adult content filter and a time window for EPG entries that states how far in the future EPG entries are considered. These filters can be set over an administration interface.

**Details on the Meta Data-based Linking Strategy**

In order to link videos, we have focused on two major sources: genre information and persons (actors, directors, producers). We have explored others as well like movie length, production year, original language etc. but we have found that the first two provide the most meaningful results. Table 1 provides an analysis of EPG genre tags from a real-world data set for 66 broadcast channels, with entries ranging from July 31st to August 18th 2007, where the category tags for each broadcast have been extracted. Most of the 2803 entries in the data set had more than one category assigned, a total of 9318 have been found. Curiously, the most prominent topic was ‘Special Interest/Other’ followed by additional ‘don’t care’ categories. The table shows the most popular 36 out of 198 categories, the total list contains also very specific information like three references to distance learning or one to archaeology. As a consequence, we have applied this frequency list to weigh the links between

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special Interest/Other</td>
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</tr>
<tr>
<td>Entertainment/Show</td>
<td>63</td>
</tr>
<tr>
<td>Movie/Other</td>
<td>60</td>
</tr>
<tr>
<td>Series/Suspense</td>
<td>51</td>
</tr>
<tr>
<td>Series</td>
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<td>Regional</td>
<td>46</td>
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<td>51</td>
</tr>
<tr>
<td>Documentary</td>
<td>92</td>
</tr>
<tr>
<td>Crime</td>
<td>48</td>
</tr>
</tbody>
</table>

Table 1: Frequency of Category topics (the 7660 most popular entries out of 9318)
single items based on the expressiveness of the link – the smaller the category group the more specific the topic, the higher the link weight.

The video-on-demand pool contains movies that are tagged with actors and genre information in a similar manner. We had to introduce some pre-processing steps for term unification to make the tag sets compatible and manually map non-standard categories to EPG equivalents in order to get a good linkage between both data pools so that people can navigate in live and recorded entries alike.

Besides the basic linking, we have introduced some filters that select a meaningful subset of the EPG data: we limit viewable entries to a time-window from currently running broadcasts up to the next 36 hours. Furthermore, many broadcasts don’t show actors in the EPG meta-data (service magazines, news broadcasts, documentaries and the like), but do offer meaningful visual information – a preview image. Others do not offer this visual feedback. As this is a significant percentage, we have decided to not show these in the user interface, as the visual quality was poorer – we had to show a standard icon in many cases, which frustrated our testers quickly.

We found that linking movies via persons is – at least in the EPG domain – a harder problem, as can be seen in Fig. 3, which shows the single actors (green nodes) that link to the broadcasts they occur in (grey nodes). We have created the graph with the same input data and already filtered out entries that did not have actors, which eliminated hundreds of islands (single nodes), nevertheless, the data set is still fragmented in hundreds sub-graphs. Furthermore, the created links are not always intuitive, the larger ring structure on the left, for example, links Baywatch via David Hasselhoff to Knight Rider at the top of the ring, via James Luisi to T.J. Hooker, again over William Shattner to Boston Legal, Rene Auberjonois to Deep Space Nine, from there over Brian Keyt to Rivalen der Liebe, which connects back to Baywatch over Alexandra Paul – a great mix of genres, topics and contents.

**Graph-creation and Navigation**

As time advances and users enter feedback to the system, the link weights and the links of the graph change – new items appear, old entries drop out of the list and orders can change depending on user preference. Two strategies exist to reflect these changes in the graph to enable efficient browsing: Either the whole graph is (re)computed in advance, or only a local subset is created. For the first approach, variants of a spanning-tree algorithm can be used to create a graph with minimal navigation steps. This has to be done on every change, for every user (considering per-user preferences), which implies a considerable scalability issue.

For a local computation setup, the next possible neighbours are computed at each navigation step, and only a local subset is extracted from the list. This does not create an optimal graph structure, and can create loops if navigation history is not considered, as the weighing algorithm ensures that always the best links are chosen. We use a history list for sorting out already-seen items to always present new entries to the user (and one link back), so there is always a maximum of new information available. Furthermore, the path the user navigation along influences which items are presented – for different paths a different visualisation is created, which creates the impression of a larger data space the user can explore, which reflects the casual content browsing in contrast to goal-oriented content search. This approach is juxtaposed to other graph-creating algorithms like the minimal spanning tree and consorts) that would guarantee a minimal number of navigation steps from one end of the graph to the other but rely on a static graph structure – our graph changes constantly due to the changing content of the life broadcast channels and as current users vote for their most popular content.

**Conclusions**

With the Media Space Navigator, we have successfully transferred a graph-based navigation metaphor from the PC into the TV interaction domain. The feedback from an initial set of test users gathered during a three-day multimedia exhibition showed that the presented approach is easily understood by a demographic diverse community and is a valuable extension of traditional browsing mechanisms that enforce a more static ordering of contents in genre/subject-genre lists.

The presented prototype has been focused on using EPG-provided meta-data for video contents. We are considering extending this approach in several respects: We will add a user-activity based recommender system as soon as an initial set of test-users has access to the interface, which frees us from limited meta-data quality and introduce the social aspects of Web 2.0 to the TV domain, which should give users the feeling of a more personal experience. In addition, other data sources that have suitable meta-data could be included into the browser, as long as matches between tags can be found – tags on user-generated videos, from online photo sites, wiki pages could seamlessly add web-based data to the navigation interface.

**References**


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