

Online Television Library: Organisation and Content Browsing for General Users

Kieran Mc Donald*, Alan F. Smeaton, Seán Marlow, Noel Murphy, Noel E. O'Connor

Centre for Digital Video Processing, Dublin City University, Ireland

ABSTRACT

This paper describes the organisational and playback features of Físchlár, a digital video library that allows users to record, browse and watch television programmes online. Programmes that can be watched and recorded are organised by personal recommendations, genre classifications, name and other attributes for access by general television users. Motivations and interactions of users with online television libraries are outlined and they are also supported by personalised library access, categorised programmes, a combined player browser with content viewing history and content marks. The combined player browser supports a user who watches a programme on different occasions in a non-sequential order.

Keywords: Digital video library, Content browsing, Library organisation, Recommendation systems, Personalisation

1. INTRODUCTION

The availability of terabyte storage and video streaming technology have made it possible to build reasonably sized video libraries with high quality access across local networks. It is possible to populate such video libraries with high quality programmes taken from the current public broadcast channels.

This paper presents the user-oriented features of such an online television library, Físchlár¹. Unlike some other video systems, such as Vision² or Informedia³, we do not concentrate on news or educational programmes but instead on all broadcast television content. Also we do not assume information seekers as our users but more generally we assume general television users who may be interested in information or more likely entertainment. This would be the profile of users of such digital recorders as TiVo⁴ and ReplayTV⁵. Unlike these systems the interface in Físchlár is desktop computer based and content browsing is supported. Also the system is shared with more than just fellow house mates and no one has direct control over the storage.

The work described in this paper builds on the original Físchlár system¹, which has a web-based interface. The origin of this work is to address functional inadequacies of the original system and problems that occurred when the system was scaled up from being able to store a maximum of 40 hours to around 400 hours of broadcast television programmes. The original Físchlár system was extended to achieve better organisation of the programmes that users can watch and record, to provide personal recommendations, to support a community of users that use the service regularly, and also to support users based on our ideas on user motivation and their interaction with online television libraries. To achieve these aims we integrated a programme recommender system, a simple programme categoriser, and a combined player browser. We also achieved consistency in the organisation of the play list of pre-recorded programmes and television schedules and we provide multiple ways to access this information.

In this paper we will first give the background of Físchlár as an online television library and of its users. Next we will discuss browsing the library and then playback of the library's content in the new application-based interface. Finally we will talk about capturing content before outlining future work required and some concluding remarks.

* Correspondence: Email: kmcdon@compapp.dcu.ie; WWW: <http://lorca.compapp.dcu.ie/Video/>

2. BACKGROUND

The web-based interface to the original Físchlár system lets users record, and watch programmes from 8 terrestrial public broadcast channels¹. Users record programmes by selecting from the online television schedules that are listed by channel and by day. To watch a programme users select a pre-recorded programme from the play list. The most recent programmes are at the top of this list. The selected programme's content is displayed using keyframes of detected shots in the programme which the user can browse⁶. By selecting one of the keyframes the user starts playback of the programme from that shot onwards in a separate player window. The player has only simple play, pause, and seek controls. If the user selects another keyframe the current player will be stopped and started at the newly selected shot. The browsing interface is separated from the playback interface. Also there is no synchronisation between both interfaces.

The Físchlár system runs continuously recording, analysing and playing requested programmes. It can only record on one channel at any one time unlike the AT&TV television library⁷ which records constantly from four public broadcast channels. Also, the original Físchlár system only records programmes that its users select from the current television schedules. The oldest programme content is removed from the video library when space is required for a new programme. After recording into MPEG-1 format, programmes are analysed for shot boundaries and keyframes are identified and extracted for each detected shot.

The target users of our system are general television viewers. These users share this library of recorded programmes as any programmes recorded are available for everyone else to watch. The common purpose we assume users have is to watch television content. What users hope to maximise is the entertainment or information they gain from watching some of this television content. What they hope to minimise is the time spent locating this information and entertainment. The segments of television content that users find interesting are not necessarily the complete programmes. Also users may watch programmes such as magazines in a non-sequential order - they could watch some interview at the end of the programme before watching some movie review in the middle. They may revisit the same programme again either to watch other segments, to watch it more exhaustively or to return to some interesting scenes. Even when sequential access is all that a user wants, it is rare that the user will want to watch the programme from start to end without skipping some segments such as advertisement breaks or programme titles.

The original system was extended from 40 hours storage to 400 hours storage. The streaming technology was upgraded so that it could support well over a hundred concurrent users. A personalised television listings service, PTV⁸, was integrated to offer personalised recommendations on what the users should record and it also categorised television programmes into genres. The aims of these changes were to make it a more useful television library hence the increase in capacity and to make it easier to select programmes to be recorded hence personalised listings and categorised programmes. We also wanted to make it a more realistic test bed for a television library so with more possible users it will be possible to do better analysis of the usage of the system.

With support for the outlined user behaviour in mind, we have developed a new application-based client for Físchlár the purpose of which is to provide maximum support to our frequent users given the current technology we have at our disposal. Also paramount was the need to bring consistency into how users access the television schedules and library content. The library capacity had grown to 400 hours and was in a real need of more advanced access methods than a simple list of programmes. Also it would be a better system if it did not always require explicit user initiated capture of content but could capture content on its own accord when its recording schedule was free. It was also recognised that navigation of the content was hampered by not having a browsing interface combined with the playback interface. Users of the existing playback interface were reduced to blind seeking to skip uninteresting pieces of the programmes or had to spend considerable time trying to find the current playing position in the browsing interface in order to use it to navigate during playback.

3. BROWSING THE LIBRARY

In the application-based client users can browse the library and its content in a single interface (Figure 1). In the left pane the user can select which group of programmes to list. In the top pane the selected group's programmes are listed and the user can select one of the programmes. In the bottom pane the selected programme's content can be previewed or browsed.



Figure 1. Library browsing interface.

There are 4 main groups the user may browse - the whole library, their inbox, their quick links and the television schedule.

3.1. The Library

Selecting the library group will cause all the programmes in the library to be listed.

A user may not always want to browse through the complete television library. We allow users to view a smaller list of programmes by choosing filters that appear below the television library node. They can select recommendations, or the favourites filter to list only those programmes in the library that are recommended for them or in the latter case only those programmes that the user has previously indicated are liked.

Other useful filtered lists are created from the 'by channel' filters and the 'by category' filters. If a user is interested only in programmes broadcast on the RTE 1 channel then s/he can open the 'by channel' filter and select RTE 1. The category filters work with manually configured category profiles. Each category profile contains words and names to look for in the programme's name and description. A programme may belong to many categories. By using these filters the user can slice through the large programme lists, thereby creating smaller lists for them to browse, or to find the programme they are searching for.

When a user is browsing through the list of programmes, these may be rated by using the thumbs and question mark icons on the right hand side of the programme entry in the list. For this we use a five point scale - hate, dislike, okay, like, love. All programmes within the same series are treated as one entity - if the user marks an episode of 'Fair City' as 'I like it' then whenever there is a 'Fair City' programme the system gives it this user rating. By rating programmes the user is improving

the usefulness of the favourites filter and s/he is also keeping the recommendation system better informed of the programmes s/he currently likes. Recommended programmes are indicated in the list with red exclamations beside their name.

When a user selects a programme in the list a preview of the programme is displayed. A programme that has not been previewed is in bold typeface and those that have been previewed are in normal typeface. This allows the user to identify the programmes that are new. It is also useful to indicate to the user whether they have actually played any of the programmes before and so just before the rating in the list there is a bar highlighting the portions of the programme they have watched. Unseen content is indicated in blue, watched content in black. The user can get an impression of how much of the programme they have watched and the temporal distribution of these watched sections.

A user may flag or unflag a programme by clicking just left of the programme name. It is often useful to flag a programme just to discriminate it against other programmes. A user might flag a programme that looks good from the preview but which they currently do not have time to watch or may use it as a memory aid as they browse through the list of programmes in search of other programmes to watch.

If the user wants to give the programme some textual note as well, then s/he may use the note facility in the preview pane. A note icon will appear beside the programme name indicating the note's existence. The note also appears in the tooltip for the list entry for the programme.

The number of programmes listed can be quite large. For the whole library there would normally be over 400 programmes listed. To be able to browse these large lists the user needs to be able to sort them by meaningful attributes and then a user would generally look at the programmes one by one. For television programmes their name, channel, day, date and time are useful attributes for users. Length is also useful if the user wants to find a short programme to watch completely in a limited time. The currently selected programme before the sort is visible after the sort and there is an indication of how the list is currently sorted. A click on the column header is the gesture required to sort by an attribute. The attribute is displayed in bold and the direction of the sort is indicated which can be changed with another click of the same heading. This is similar to email applications.

After selecting the most recent 'Fair City' programme in the library the user might sort by name to check whether s/he has watched the previous episodes. Also the user may sort the programmes by whether they have watched the episodes or not and to what degree. The user may wish to sort the programme list in the order they like the programmes - from programmes they love to programmes they hate. By clicking on the rating header the user may sort the list by their likes and dislikes. Unrated content will appear at the end. The user can click the recommendation column header to line up all the recommended programmes together.

Finally, being able to sort by flag or note is a quick way for a user to locate the flagged programmes or the programmes that have a user assigned note.

Some users may not require all these attributes or may wish to remove the clutter. They can do this by right clicking on the header and unticking the columns they do not want. This is easily reversible by ticking the column name. Reordering and resizing of columns is also supported.

The default preview tab, summary, displays the programme attributes, its description and any notes the user has given this programme episode. It also displays a content overview. This is a small number of keyframes taken evenly across the whole duration of the programme. Preference is given to keyframes of longer shots in the selection of the keyframe to represent each segment of equal duration. This discriminates against selecting a keyframe from the advertisement breaks when the represented segment overlaps an advertisement break. Underneath each frame in the content overview is a bar indicating which portion of that segment the user has watched.

The purpose of the summary tab is to give the user an impression of the full programme without forcing a browse of content. This is to allow one to swiftly go through programmes in the list and to get an impression of their content without having to interact with the preview interface.

The content tab of the preview, in contrast, displays all the shots in the programme. If this is used as the content abstraction then the first one or two minutes of the recorded programme is all that is visible without scrolling down further. Commercial content can often have over 600 shots per hour and usually when Físchlár records a programme there are advertisements recorded before the programme actually begins. This would force a user to continually jump between selecting a programme and scrolling the contents and back again.

The content tab is useful when used in conjunction with the programme list when a user is trying to find a scene in a programme and there are a couple of programmes that scene could be in, for example finding the wedding scene or some fight scene in one of the many recorded episodes of 'Fair City'.

The marks tab lists any marks the user may have created for different temporal locations in the video content. The marks may have been created on a previous watching of the content to mark some interesting segments.

If the user selects a mark or any of the keyframes, playback of the programme will start in a separate window from the temporal location associated with the keyframe or content mark.

3.2. Inbox

Users browse through the library to locate programmes for playback. For a frequent user locating programmes for playback initially becomes a check to see if there are new programmes recorded and then a quick glance at them to see if they are worth watching. Bolding new programmes that they have not previewed and showing the playback history of the programmes are useful for this task.

However it is better to have a group, inbox, dedicated to the purpose of listing what is new and to have a count associated with this group indicating how many new programmes there are in it - so that the users immediately know if there are new programmes. An inbox is appended with new content since the last visit to the library and programmes can be deleted from an inbox. This allows users to incrementally manage what content is relevant to them by deleting programmes viewed as junk or those which no longer have any usefulness from an inbox. Of course the content is still available from the library group should it be required again later.

The filters are also available for the inbox group. If they expand the inbox node the same filters that are available for the library node are displayed. Also the programmes can be sorted, marked or notes made of them as before.

Just putting all new content into a user's inbox may be too lenient a rule for some users - especially if we scale our capture process to be able to record simultaneously from multiple broadcast channels. So some users may have a more restrictive inbox where only the new content that they have previously indicated they like, or the recommendation system thinks they like is included. The inbox may also be set up to include all new content except that which users have indicated they dislike.

3.3. Quick Links

The quick links are links to whole or parts of programmes. These links are a quick way to start playback and browsing from a specific point in a programme in the video library. A user can give the quick link a text label for easier subsequent reference. In the list of quick links there are two extra attributes that are displayed - label and position. A user creates a quick link by right clicking a programme's content mark or one of its keyframes and choosing the quick link option.

A user may structure quick links into folders and can arrange these logically without caring which programme the link refers to. For example, if there is an hilarious moment in 'Friends' the user can add this to their quick links. When finding that moment again the user will not have to go to their inbox, or library to locate the proper 'Friends' episode and then look at its local content marks for the scene. Instead they would have a direct link to this part of the programme in their quick links.

The television library's contents are temporary and as a result any quick links will have a limited lifetime before they are broken at which time the links are removed and disappear. On average video content is available for 25 days in the current system. However if we increase our capture process to more simultaneous channels without increasing our storage capacity this will drop.

3.4. Television Schedule

The interface for browsing through the television schedules is similar to that for browsing through the library or inbox. There is no preview panel and there is an extra option to select a programme to be recorded. The purpose of the television schedule is to see what is on television in the next couple of days and also to explicitly tell the system to record a programme.

4. PLAYBACK OF CONTENT

The playback interface is displayed in a separate window from the library browsing interface and it has three modes – normal, compact and full screen. In compact mode only the player and its controls are visible. The controls allow the user to play, pause, and seek to a different point in the programme. In normal mode this is supplemented with a content browsing interface, note making and content marking interface. However in full screen mode the interface acts like a television displaying only the playback screen. The user can switch between these three interface modes during playback and browsing of the programme's content.

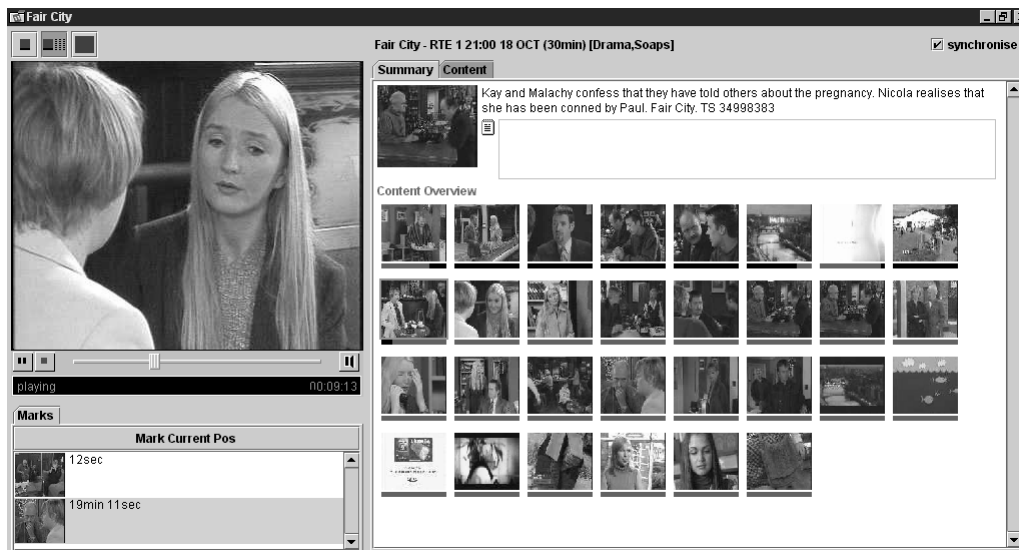


Figure 2. Combined player browser with summary tab shown.

In normal mode, the summary tab of the combined player browser (Figure 2) gives the user an overview of the progression of playback in relation to the whole programme. Under each image is the playing history associated with that segment of the programme – blue for unwatched, black otherwise. Users can jump to different segments by clicking on the keyframes but this interface allows only very coarse navigation. As users are watching programmes it is possible to add a short note to the programme. This can be used to differentiate this episode of the series from others or simply as a memory device for the user.

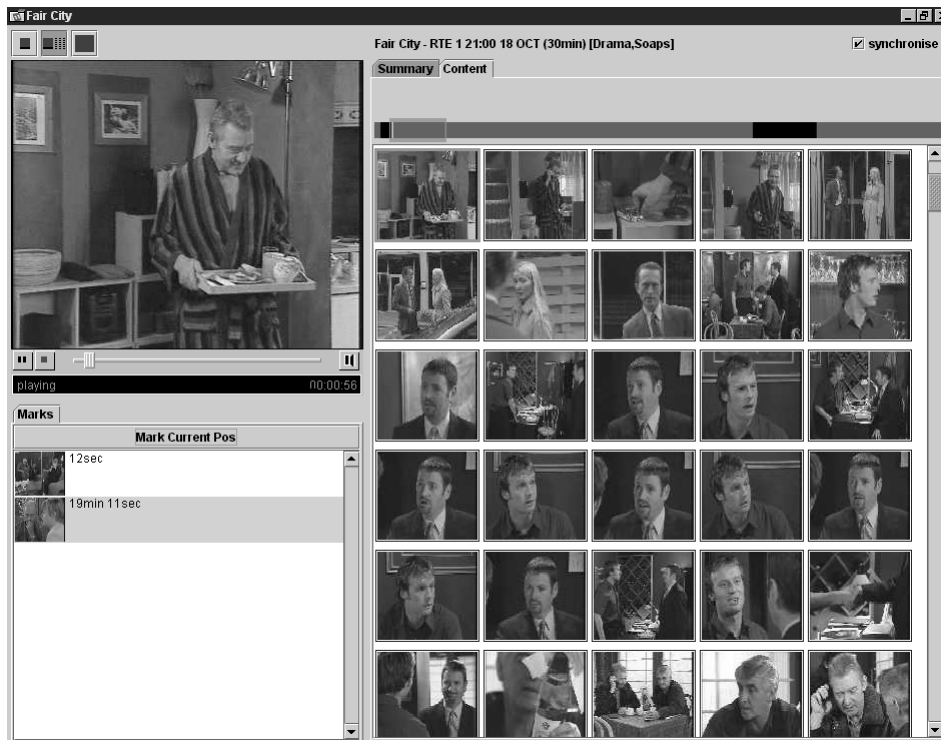


Figure 3. Combined player browser with content tab shown.

The content tab of the combined player browser (Figure 3) shows all the shots, represented by their keyframes, in the programme. The currently playing shot is indicated with a thick green border. By default this view is synchronised with playback so that the playing shot is always visible. This is similar to the synchronisation of transcripts with playback in the FRANK⁹ video client. Each shot that has not been played has a blue border around it. If a user selects a keyframe from the browsing interface playback is moved to the start of the respective shot. This interface helps the user to identify interesting segments of the programme to watch that can be anywhere in the programme. It also allows the user to skip boring segments such as advertisement breaks or programme introductions which may occur during playback which are easily identified visually. They may ignore the content view while concentrating on playback and when they need it, it is synchronised and ready for use. Often glancing at it without any interaction will provide a visual summary of the next one or two minutes. If the user is not interested in what is currently playing and sees no change of content of interest in the next minute s/he can use the interface to locate some interesting segment and move playback to it.



Figure 4. User seeking timebar to different position.

Above the keyframe list in the content tab is the timebar (Figure 4). This indicates the browsing and playback position temporally. The browsing position is indicated using a rectangular border around the temporal segment that is currently visible in the browsing interface. The play position is indicated as a green bar in the timebar.

The playback history is also themed across it – again blue for unwatched, black otherwise. The user can use this to seek the browsing interface to different parts of the programme. However this is not blind seeking as when the user puts the mouse over the bar feedback on the position s/he would move the browsing interface to if clicked, is shown. This feedback is in the form of a keyframe, with the absolute time and relative time from playback shown of the shot the user would seek the

browsing interface to. To actually move playback to this position a user must click on the keyframe in the browsing interface. Of course a user may drag the timebar in which case it behaves like a scrollbar but the position is temporally calculated and not related to the number of shots as would control the scrollbar units.

The user may unsynchronise the browsing interface from playback by unticking the synchronise checkbox. However if the interface is synchronised and s/he tries browsing using the scroll bar or the timebar the interface will cede control and untick synchronise automatically.

The history mechanism helps the user to return to a programme to finish watching it as it is easy to find where to continue watching from. This also allows a user to watch programmes in a non-sequential order such as for a magazine programme since it is immediately clear while browsing through the content whether the represented shots have been seen previously or not.

Finally, users can mark parts of the programme content. This can be used to indicate interesting segments, or parts that they will return to watch again. A user can mark the currently playing shot or can use the browsing interface and mark a shot somewhere in the programme by right clicking the keyframe and choosing the mark option. The user can add a description to the mark if s/he so needs. These are local marks to the programme but a user may add the mark to the personalised quick links. Local marks are primarily for navigating the content or to mark out interesting parts within a programme. Double clicking them moves playback to their position.

5. CAPTURING CONTENT

The user uses the browsing interface to tell the system what programme to record. This is a chore and it is not something that gives the user an instant payback. The capture process is a limited resource in our system. It is necessary to try capture as much new content as possible that our users would like to watch. Recognising the wastage of having the limited capture process idle we have changed the capture system so that when there is a free gap in the recording schedule Físchlár can use the recommendation information itself to decide if there is a programme worth recording for existing users within that available time slot.

Users who use the system and especially those who let the system know what programmes they like are rewarded by the system recording these programmes even if they have not been explicitly set up to be recorded. Also because we use the recommendation system, content that may have not been rated by the current users may be recorded because the system thinks some of our users would like it.

6. FUTURE WORK

Usability testing needs to be performed on the new interface to the Físchlár system and changes made accordingly. Evaluation of the interface for new or short term users is useful but rather limited. Trial tests will be performed over a period of a few months in order to identify the real trends, usefulness and defects with the system. It would be hoped that such research would identify more clearly the requirements of an online television library. Currently, the demands of TiVo and ReplayTV users are one of the only sources of expression of user requirements.

The browsing interface is rather limited. The user can only browse the content using keyframes of shots. The dialogue will need to be represented in the browsing interface and can easily be captured with closed captioned programmes. The browsing interfaces can be supplemented with other browsing methods¹⁰ which have different strengths and may be better suited to certain users or tasks¹¹.

With the addition of other attributes of the broadcast such as captions (closed or open) it would be possible to extend the concept of the inbox to more of an alert box. Topics and text based filters could be used to also identify possibly relevant programmes or parts of programmes and to place these in the user's inbox. It would also be useful for the user to create sub folders within this alert box and to indicate for each filter where the programme should be placed. In a system which allows access to separate television archives the user should still have a single inbox and each programme would have an extra attribute server that they can filter or sort on.

7. CONCLUSIONS

The hardware infrastructure is available to build reasonably sized television libraries. The capabilities of such system are far greater than just simple select and play video-on-demand systems. When watching television programmes the decisions the users have to make are not between watching this channel or one of the others. Users don't need to continually jump between channels just in case there is something better on another channel and the television schedule or programme listing does not matter as much as in conventional television viewing.

When a user turns on an online television client, s/he has access to hundreds (far greater than thousands in a few years) of programmes. A user can browse, watch, stop, and change to a different programme and return back without missing anything. The decision making process is very different to the current multiple channel television viewing environment.

For sure, we do not currently know our user requirements but it is possible to try to build a user model and to extract system requirements from this and then to build such a system and after that to test and evaluate the system with users over a couple of months. This is our plan for the Físchlár system which we will shortly deploy to over 100 test users in our University residences. From this evaluation, which is the subject of future work, we will be able to refine our user model and user requirements and in the future build a better, more user-oriented online television retrieval system.

ACKNOWLEDGEMENTS

The authors would like to thank Paul Cotter, of Changing Worlds, for his help and advice when integrating the Personal Television Listings Service, PTV, with Físchlár.

REFERENCES

1. H. Lee, A. F. Smeaton, C. O'Toole, N. Murphy, S. Marlow, and N. E. O'Connor, "The Físchlár Digital Video Recording, Analysis and Browsing System," *Proceedings of RIAO'2000: Content-Based Multimedia Information Access*, pp. 1390-1399, 2000.
2. W. Li, S. Gauch, J. Gauch, and K. M. Pua, "VISION: A Digital Video Library," *Proceedings of the 1st ACM Conference on Digital Libraries*, pp. 19-27, ACM Press, New York, 1996.
3. H. D. Wactlar, T. Kanade, M. A. Smith, and S. M. Stevens, "Intelligent Access to Digital Video: Informedia Project," *IEEE Computer* **29**(5), pp. 46-52, 1996.
4. TiVo, <http://www.tivo.com>, (visited October 2000).
5. ReplayTV, <http://www.replaytv.com>, (visited October 2000).
6. H. J. Zhang, C. Y. Low, S. W. Smoliar, and J. H. Wu, "Video Parsing, Retrieval and Browsing: An Integrated and Content-Based Solution," *Proceedings of ACM International Conference on Multimedia*, pp. 15-24, ACM Press, New York, 1995.
7. T. J. Mills, D. Pye, N. J. Holinghurst, and K. R. Wood, "AT&TV: Broadcast Television and Radio Retrieval," *Proceedings of RIAO'2000: Content-Based Multimedia Information Access*, pp. 1135-1144, 2000.
8. B. Smith, and P. Cotter, "A Personalized Television Listings Service," *Communications of the ACM* **43**(8), pp. 107-111, ACM Press, New York, 2000.
9. B. Simpson-Young, and K. Yap, "FRANK: Trialing a system for remote navigation of film archives," *SPIE International Symposium on Voice, Video and Data Communications*, 1996.
10. H. Lee, A. F. Smeaton, C. Berrut, N. Murphy, S. Marlow and N. E. O'Connor, "Implementation and Analysis of Several Keyframe-Based Browsing Interfaces to Digital Video," *Proceedings of the 4th European Conference on Research and Advanced Technology for Digital Libraries, ECDL 2000*, pp. 206-218, Springer-Verlag, Berlin, 2000.
11. A. Komlodi, and G. Marchionini, "Key frame preview techniques for video browsing," *Proceedings of the 3rd ACM Conference on Digital Libraries*, pp. 118-125, ACM Press, New York, 1998.