Dublin City University Video Track Experiments for TREC 2001

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Abstract

Dublin City University participated in the interactive search task and Shot Boundary Detection task[*] *of the TREC Video Track. In the interactive search task experiment thirty people used three different digital video browsers to find video segments matching the given topics. Each user was under a time constraint of six minutes for each topic assigned to them. The purpose of this experiment was to compare video browsers and so a method was developed for combining independent users' results for a topic into one set of results. Collated results based on thirty users are available herein though individual users' and browsers' results are currently unavailable for comparison. Our purpose in participating in this TREC track was to create the ground truth within the TREC framework, which will allow us to do direct browser performance comparisons.*

1. Introduction

This year Dublin City University took part in the video track where we submitted runs for both the interactive search task and the automatic shot boundary task. Firstly we will present our experiments and results for the interactive task in section 2. In section 3 we will briefly discuss our Shot Boundary Detection experiments. Although we have an interest in the Shot Boundary Detection task our primary focus was on participating in the interactive task. We have submitted some Shot Boundary Detection results and are continuing our research into the area and look forward to being in a position to participate more fully in the Shot Boundary Detection task next year, should it run.

2. Interactive Search Task

For the interactive search task we undertook to evaluate 3 different interfaces for browsing digital video. In the following sections we will give an overview of the system that was created in order to evaluate the browsers, then the evaluation procedure for experiments, followed by how experimental data was collated from the different users and finally we will present our initial analysis of the results.

2.1 System Description

For the interactive search task, we used 3 of the 8 video keyframe browsers available in the Físchlár system. The Físchlár system is web-based and allows users to record, browse, and watch television programmes online [O'Connor *et al.* 01]. For this experiment we created a separate interface (Section 2.1.2) from Físchlár. The 3 browsers were chosen for the large differences among them in the way they presented the keyframes (representative frame from each video shot), while at the same time all of them had the same dynamic and immediate response style of interaction. The test users used all these browsers to locate the video clip results for interactive queries.

[*] Work on the Shot Boundary Detection task was done in collaboration with the Multimedia & Vision Research Lab in Queen Mary, University of London, U.K.

2.1.1 The Three Browser Interfaces

The underlying Físchlár system processed the TREC video set to automatically extract keyframes for each video and the 3 browsers present these sets of keyframes in 3 different ways. The 3 browsers are the Timeline browser, Slide Show browser, and Hierarchical browser. These are described here briefly.

The *Timeline* browser (see Figure 1) presents keyframes in a linear fashion. When a user selects one of the videos, the first 24 keyframes are displayed on the screen, with that part of the video indicated on the timeline at the top. Keyframes are miniaturised so that many of them can fit on the screen while still the content of each is recognisable. The timeline is broken into segments, each representing the appropriate time when the 24 keyframes below appear in the video. The timeline is mouse-over activated so when the user moves the mouse cursor over any of the timeline segments, the keyframes immediately change to display that part of the video on the screen. This way, one sweep of the mouse through the timeline bar from left to right can quickly present the whole keyframe set of a video. When a mouse cursor is on the timeline, a small ToolTip pops up to indicate the time of that segment.

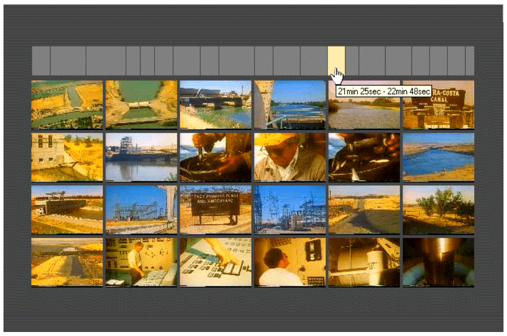


Figure 1: Timeline browser

The *Slide Show* browser (see Figure 2) presents keyframes one by one, in a temporal fashion. When a user selects one of the videos, keyframes from the video will be displayed one by one, automatically flipping from one keyframe to the next as in a slide show. The size of the keyframes is larger than in the Timeline browser, as it shows only one keyframe on the screen at a time. The user has control over the keyframe flipping – she[*] may pause the slide show, flip through manually by clicking the forward and backward buttons, or leave it to do the slide show by itself. Also the user can put the mouse cursor over the small timeline below the keyframe, and drag the current point quickly back and forth, similar to the Timeline bar. When the mouse cursor is on the timeline, a box pops up displaying a small keyframe (smaller than the miniaturised keyframes in the Timeline browser) representing the cursor's point in the timeline along with the time of that point.

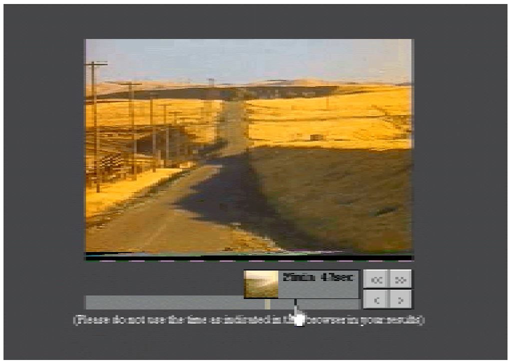

21min 47sec
<<
>>
<
>
(Please do not use the time as indicated in this browser in your results)

Figure 2: Slide Show browser

The *Hierarchical* browser (see Figure 3) presents keyframes in a 4-level, hierarchical fashion. When a user selects one of the videos, 6 keyframes that are representative of the video are displayed on the screen (the top 6 keyframes in Figure 3). These 6 keyframes are selected throughout the chosen video's content, representing a rough overview of the video. When the user moves the mouse cursor over any of these 6 keyframes, another 6 keyframes within the segment represented by that keyframe are displayed just below the top 6 keyframes, showing more details of that segment. The user can again move the mouse to this second level of keyframes to show 6 more detailed keyframes below it.

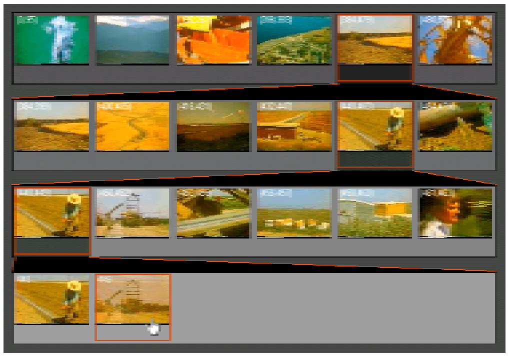


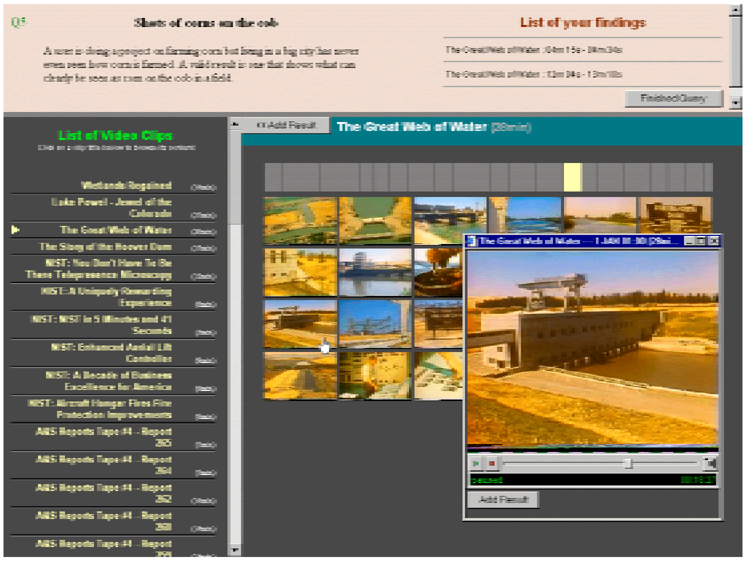
Figure 3: Hierarchical browser

This way, the user can quickly move the mouse cursor over any keyframe displayed on the screen, hierarchically drilling up and down the keyframe set. This particular style of keyframe browsing has earlier been mentioned elsewhere [Mills *et al.* 92] [Zhang *et al.* 95].

[*] There are, of course, male users as well.

2.1.2 The Evaluation Suite

We used a specially designed, automated web-based evaluation suite for the interactive testing, which integrated all the test users' tasks to be conducted. Test users were presented with a user-interface that presents each of the queries, one of the 3 browsers to do the search task, and an input panel to indicate the findings. Figure 4 shows a screen shot from the user-interface of the evaluation suite. When the user clicks the start button (not shown in Figure 4), the first query window pops up with its description and example images and videos (if examples are provided by the query). The user can close the query description window to do the search task, but the description part remains on the top left of the screen (in Figure 4) so that she can refer to it while doing the task. The bottom left side of the screen shows the list of video clips. The user can click on a video title in this list to see the keyframes of that video on the right side, with one of the pre-determined browsers. For any of the 3 browsers that are used for a task, clicking on any of the displayed keyframes will pop up a small player window that starts playing the video from the clicked keyframe onwards. When the user browses and finds a part of the video which she thinks satisfies the query, she clicks the 'Add Result' button either on the browser screen or on the player window, which pops up an input panel window where the user indicates start and end time of the video result. The indicated finding will be added on the list at the top right side of the screen for the user to see, and as she finds and adds more results, this list will grow. Once a result is added it cannot be edited or deleted. The user will continue the search task until the experimenter asks her to stop (in 6 minutes - see Procedure section below).



Q5

Shots of corns on the cob

A user is doing a project on farming corn but living in a big city has never even seen how corn is farmed. A valid result is one that shows what can clearly be seen as corn on the cob in a field.

List of your findings

The Great Web of Water : 04m 15s - 04m 34s

The Great Web of Water : 13m 04s - 13m 18s

List of Video Clips

Click on a clip title below to browse its content

Wetlands Regained

Lake Powell - Jewel of the Colorado

The Great Web of Water

The Story of the Hoover Dam

NIST: You Don't Have To Be There Telepresence Microscopy

NIST: A Uniquely Rewarding Experience

NIST: NIST in 5 Minutes and 41 Seconds

NIST: Enhanced Aerial Lift Controller

NIST: A Decade of Business Excellence for America

NIST: Aircraft Hangar Fires Fire Protection Improvements

ABS Reports Tape #4 - Report 265

ABS Reports Tape #4 - Report 264

ABS Reports Tape #4 - Report 262

ABS Reports Tape #4 - Report 260

ABS Reports Tape #4 - Report 259

The Great Web of Water (28min)

The Great Web of Water --- 1 JAN III :30 (29si...

Figure 4: Evaluation suite

Table 1: Test user demographics

by gender		by status	
Male Female	18 12	Undergraduates Postgraduates Staff	10 19 1
Total	30	Total	30

2.2 Evaluation Procedure for Experiments

The test users volunteered within the School of Computer Applications and the School of Electronic Engineering, and were asked to come to a computer lab where the testing was to be held.

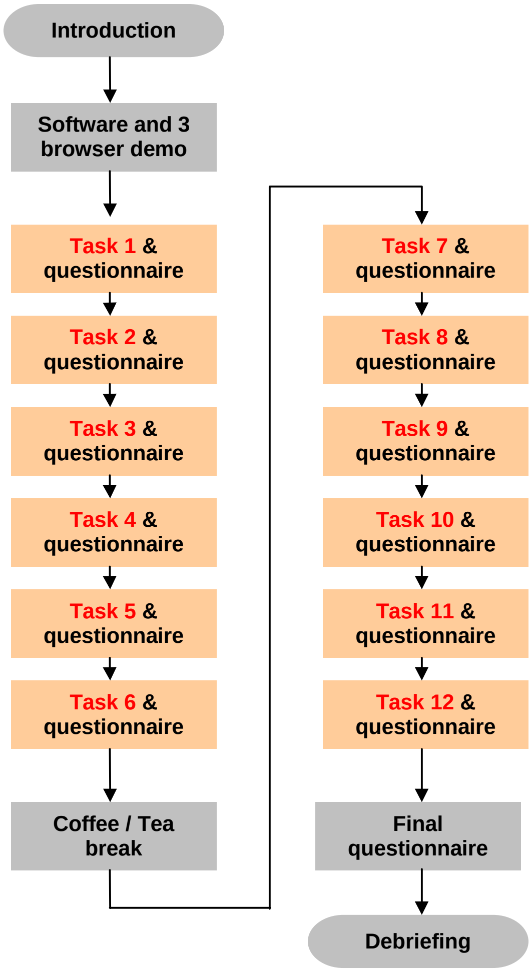
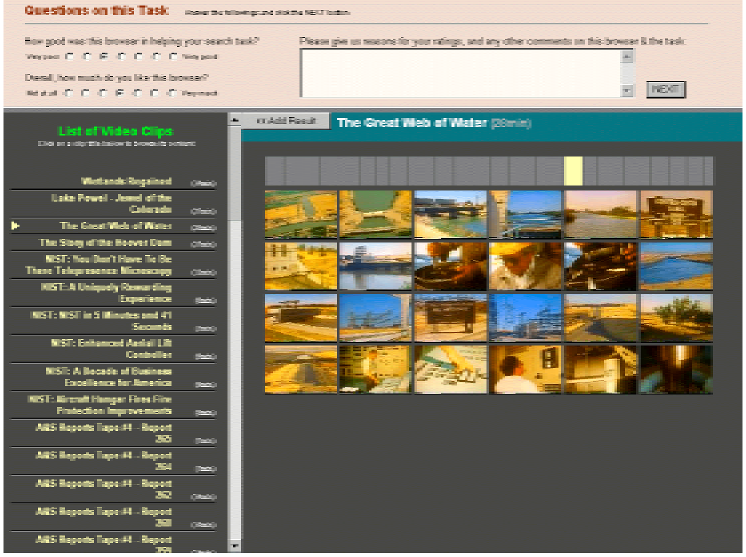


Figure 5: Session procedure

2.2.1 Evaluation Environment

In each session 5-7 test users participated, depending on their time availability, and a total of 6 sessions were conducted on different days. The total number of participants was 36 people, from which 6 people's results were discarded due to a network congestion problem that disrupted the tasks of those people. The demographics of the test users are in Table 1. They were all experienced users of the Microsoft Windows operating environment.

Each session took about 3 hours, but the exact time varied due to test users who came late, their questions during the introduction and debriefing stage. Test users sat in front of their assigned PC with the web browser displaying the first screen of the specially designed web-based suite for this evaluation. Test users filled in a very short demographic questionnaire asking gender, course/year, and familiarity with Físchlár browsers. The question of familiarity with the browsers was asked because the system had a wide availability within the campus and many students have been using its browsers on a daily basis, which would make differences in their task performance. Then the experimenter briefly gave an introduction, thanking them for their participation, telling them what the purpose of the testing was, how long it would take, and how stressful it would be. They were informed that they could leave at any point if they felt unhappy, frustrated or too stressed, and that the information they provided would be confidential and only used for research purposes.



Questions on this Task Answer the following and click the NEXT button.

How good was this browser in helping your search task?

Very poor ○ ○ ● ○ ○ ○ ○ Very good

Overall, how much do you like this browser?

Not at all ○ ○ ○ ● ○ ○ ○ Very much

Please give us reasons for your ratings, and any other comments on this browser & the task:

NEXT

List of Video Clips

Click on a clip title below to browse its content

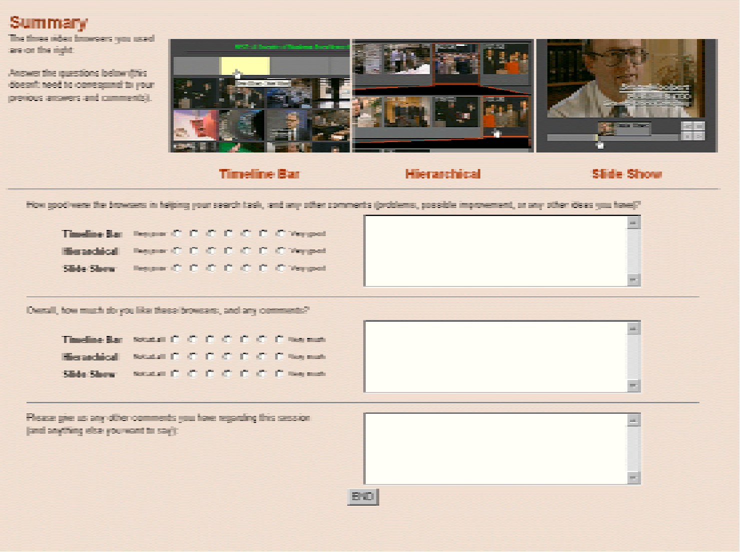
- Wetlands Regained (Check)
- Lake Powell - Jewel of the Colorado (Check)
- The Great Web of Water (Check)
- The Story of the Hoover Dam (Check)
- NIST: You Don't Have To Be There: Telepresence Microscopy (Check)
- NIST: A Uniquely Rewarding Experience (Check)
- NIST: NIST in 5 Minutes and 41 Seconds (Check)
- NIST: Enhanced Aerial Lift Controller (Check)
- NIST: A Decade of Business Excellence for America (Check)
- NIST: Aircraft Hangar Fires Fire Protection Improvements (Check)
- ABS Reports Tape #1 - Report 265 (Check)
- ABS Reports Tape #1 - Report 264 (Check)
- ABS Reports Tape #1 - Report 262 (Check)
- ABS Reports Tape #1 - Report 260 (Check)
- ABS Reports Tape #1 - Report 259

<< Add Result The Great Web of Water (28min)

Figure 6: Post-task questionnaire

After the introduction, the experimenter and 2 - 3 more assistants (who stayed and helped during the sessions) gave a 10 - 15 minute demonstration by gathering 3 - 4 test users in a group. They showed them how to interact with the evaluation software (i.e., how to start, how to use 3 different browsers, how to add the findings into the result list, how to proceed, etc.), and replied to the questions the individual test users had.

After the demonstration, the experimenter asked the test users to start the first task and started the stopwatch. Each task lasted 6 minutes, during which time the test users read the assigned query with example images and/or video clips and tried to find the segments matching the query and add results. The query and the video browser they used were automatically assigned (see Section 2.2.2). They were asked to find as many answer segments as possible, for there can be more than one answer for a query. After 6 minutes of the task, the experimenter asked them to stop the task and click the "Finished query" button, which brings them to a short questionnaire asking them to indicate how good the browser was in completing the task, how much they liked the browser, and then an open question about the browser and the task (see Figure 6). While filling in this questionnaire the browser was available on the bottom of the screen so that the users can still try the browser. During this period the experimenter and the assistants stayed away



Summary

The three video browsers you used are on the right.

Answer the questions below (this doesn't need to correspond to your previous answers and comments).

Timeline Bar Hierarchical Slide Show

How good were the browsers in helping your search task, and any other comments (problems, possible improvement, or any other ideas you have)?

Timeline Bar Very poor ○ ○ ○ ○ ○ ○ ○ Very good
Hierarchical Very poor ○ ○ ○ ○ ○ ○ ○ Very good
Slide Show Very poor ○ ○ ○ ○ ○ ○ ○ Very good

Overall, how much do you like these browsers, and any comments?

Timeline Bar Not at all ○ ○ ○ ○ ○ ○ ○ Very much
Hierarchical Not at all ○ ○ ○ ○ ○ ○ ○ Very much
Slide Show Not at all ○ ○ ○ ○ ○ ○ ○ Very much

Please give us any other comments you have regarding this session (and anything else you want to say):

END

Figure 7: Final questionnaire

from the test users so that they could feel free to give ratings and comments without being conscious of others. After finishing the questionnaire, the users were asked to click the "NEXT" button to continue to the second task, which would again take 6 minutes.

Test users did a total of 12 tasks (i.e. 12 different queries) in this fashion, and at the end of 6th task there was a 10 - 15 minute break to provide them with rest so that their performance would not be influenced by their tiredness too much in later tasks. During the break they were provided with refreshments (coffee/tea with biscuits), and asked to feel free to go out of the lab or chat with other test users or with the experimenter and assistants while having refreshment.

At the end of 12th task (last task), the screen displayed a summary of 3 browsers with the final questionnaire (see Figure 7 above). This asks them to rate the browsers by their task completion efficiency and their subjective preference, with plenty of space for any comments and suggestions on any aspect of the browsers and the testing on the whole.

Finally, the test users clicked the "END" button at the bottom, which displayed a simple thanking message indicating the end of the session. Test users were asked to plug off the headphones or earphones they used and bring it with them.

Considering the long duration of each session of 3 hours or so, the middle break and the highly interactive and novel video browsers seemed to keep the users active and engaged throughout. There was no monetary payment for their participation, but the interaction with interesting video browsers, free refreshment and free headphones or earphones seemed to be relatively effective.

2.2.2 Avoiding Bias in the Experiments

There was concern that without careful planning the integrity of our experiments could be compromised by the problem of user bias. There are a number of reasons why this could be the case:

- A user may become too familiar with the browser interfaces as more topics were processed. Since the users were operating under time constraints it is feasible that a user may be quicker at finding relevant clips after using a particular browser on a number of previous occasions.
- A user may become too familiar with the dataset and remember where some video clips had been seen before. We had to avoid the possibility of all users processing topics in some standard order, which would aid the expected user performance on latter topics.

To avoid this problem we had to avoid presenting the users with a number of topics in a uniform order. We did not wish to limit the number of topics that a user processed and therefore we designed the experiment to facilitate each topic being processed (in random order) by twelve different users from among the total of 30 users. Each user processed twelve topics resulting in a total of 360 user results. Before running the experiments, we drew up the following constraints:

- That no user processes the same topic twice, regardless of the interface used.
- That each user processes twelve topics using the three browsers, where each browser was used four times, and the browsers were presented in random order. In this way, the results provided to the system will not be skewed by one user gaining more experience with one browser over the others.
- That each topic must be processed by the same number of users (12) and each interface used for a topic must also be processed by the same number of users (4).
- That, like the browsers, the order in which the topics are processed by each user must be random. In this way we hoped to avoid any issues arising out of the fact that many users could process a particular topic later on in the experiment when these users would be more familiar with the interfaces and dataset.

The following table shows a summary of the experiment variables.

Table 2: Experiment variables for program to generate topic and browser sequence for users

Number of users partaking in the experiments	30
Number of topics	30
Number of interfaces to evaluate	3
Number of interface evaluations (each) per topic	4
Total number of user evaluations per topic	12
Total number of evaluations carried out	360
Mean position of a topic (in order it was presented to the users) for evaluation. This value is in the range (0...11) representing (first...last)	5.5
Standard deviation of topic positions about the mean	0.8

2.3 Collating Experimental Data

Due to the lack of verification on user results as they entered them in the interface, it was necessary to correct invalid results before we could combine and rank the results for each topic. The following rules were applied in the given order to remove and correct invalid results:

- A result with *both* its start time and end time specified as "0m0s" (the default) was removed. In this case a user did not specify which part of a selected video is relevant to the topic.
- A result was removed if its start time was out of range for the specified video. It is unreasonable to do any modification of the result as the start time is invalid.
- A result with the start time specified as "0m0s" was changed so that its start time was "0m1s". Some users who wished to specify the beginning of a clip selected 0m0s but this was not allowed by the NIST checker program.
- A result with the end time specified as "0m0s" was changed to have an end time of the start time plus 1s. The results specified by users sometimes did not include an end time resulting in "0m0s" (the default) being set as the end time.
- One second was added to the end time of a result if the value of its start time and end time were equal. Some users probably considered that only one particular frame of the whole video clip was enough to meet the requirements of a specific topic. However, the NIST checker program asserts that a valid result must not have equal start and end times.
- If a result's end time was out of range or earlier than its start time, the end time of the result was modified by giving it a value of its start time plus 1 second. In this situation, it was assumed that a user specified a valid start time but erred in specifying the end time.

Having corrected or removed the invalid results, we then combined the results from each user as the TREC framework allowed us to submit only two full runs. The reader should remember that our purpose in taking part in this TREC track was to have our own relevance "clips" assessed for relevance and thus allowing us to explore our browser vs. browser comparison experiments *after* the ground truth becomes known. Because each "run" was the combination of inputs from several users, before submitting our own results to TREC we needed to remove duplicate and overlapping results. When results from the same user overlapped we replace them by a single result which overlapped the set of clips. When the overlapping results were not from the same user we took the earliest start time that is valid for the majority of overlapping results. The end time was chosen by taking the latest end time that is also valid for the majority of the overlapping results. For an overlap of only two results this simplifies to replacing them with their intersection.

Example 1:

```
<item seqNum="1" src="nad58.mpg" start="1m10s" stop="1m26s"/>
<item seqNum="2" src="nad58.mpg" start="1m12s" stop="1m34s"/>
<item seqNum="3" src="nad58.mpg" start="1m15s" stop="1m29s"/>
```

Result:

```
<item seqNum="1" src="nad58.mpg" start="1m12s" stop="1m29s"/>
```

Example 2:

```
<item seqNum="4" src="anni010.mpg" start="1m4s" stop="1m25s"/>
<item seqNum="5" src="anni010.mpg" start="1m20s" stop="3m52s"/>
```
Result:
```
<item seqNum="4" src="anni010.mpg" start="1m20s" stop="1m25s"/>
```

Finally the query results for each topic were ranked based on the number of duplicates that produced each result. The greater the number of duplicates the higher the ranking assigned to a result. For example: a result A was derived from three duplicate results and a result B from four duplicates, then result B will be allocated a higher precedence. The result items within these precedence levels were further ranked by the number of results for the video in the source results of the topic: the more results from a source video, the higher its ranking.

2.4 Interactive Search Task Results and Analysis

The precision and recall figures for our interactive search results are available in Table 3. The results for the search topics are separated into two groups, *general topics* and *known item topics*. Topics from these two groups were evaluated differently. The *general topics* are general statements of information need. The *known item topics* on the other hand are a more specific information need and their correct results, the known items, were specified during topic creation. The *general topics* have higher evaluation cost and these are evaluated using human assessors who look at each result and give a judgement of whether it is relevant or non-relevant. Currently, precision is available for these topics but recall figures for this type of search are unavailable. For the known item topics it is possible to evaluate them using an automatic method. So far, an overlap measure is used to automatically classify the results for these known item topics as relevant or non-relevant. The overlap measure has two control parameters, *minimum known item coverage* and *minimum result item coverage* that determine whether a result item is considered to match a known item. A result item is considered to match a known item if and only if the following two conditions hold:

1. The ratio of the length of the intersection of the result item and the known item to the length of the known item is at least as large as the *minimum known item coverage.*
2. The ratio of the length of the intersection of the result item and the known item to the length of the result item is at least as large as the *minimum result item coverage.*

Table 3: General Search and Known Item Precision and Recall

Search Type	**Minimum Known Item Coverage**	**Minimum Result Item Coverage**	**Precision**	**Recall**
General Search	N/A	N/A	0.84	N/A
Known Item ('low' recall, 'low' precision)	0.333	0.333	0.298	0.419
Known Item ('low' recall, 'high' precision)	0.333	0.666	0.236	0.356
Known Item ('high' recall, 'low' precision)	0.666	0.333	0.226	0.300
Known Item ('high' recall, 'high' precision)	0.666	0.666	0.164	0.237

The known item recall and precision has been calculated at four different combinations of the control parameters (Table 3). The performance of our general topic results (P=0.84) is far higher than for our known item topic results (P=0.298) even at the most generous of control parameters 0.333, 0.333. We believe that this is a result of the different evaluation methods used for the topic types instead of some fundamental difference between the topics in the two types. A lower control parameter level of say 0.2 or 0.1 may result in the overlap measure giving results that are closer to those the human assessors were giving for the topics. Further exploration of the result of the overlap measure at different control parameter values is required and this will be done by us, *post-TREC*.

The search types *known item search* and *general search* are not as distinctive as their labels and different evaluation methods may suggest. In some cases a topic could be either a known item or a general search depending on whether the submitting group indicated the results when submitting the topic. For example Topic 24: “Find all pictures of R. Lynn Bondurant" is classified as a general search. But Topic 22: "Find pictures of Harry Hertz…" and Topic 23: "Find images of Lou Gossett Jr." are classified as known item searches not general searches. Also some of the currently classified known item searches could also be classified as general. For example, Topic 30: "Scenes with buildings similar to dome-shaped House of Congress" could be a general search not a known item search. The topics that are classified into search types general and not general (known item) is more a result of whether we specified queries with known results or not, rather than of some fundamental difference.

Some of the loss of precision by our users can be put down to the lack of fine-grained frame-level editing facilities for their search results. Once a user added a search result it was set in stone and could not be refined or removed. Furthermore, a user specified the start and stop boundaries on a video clip to the nearest second, whereas the TREC evaluation is much more fine-grained than that and this obviously resulted in some irrelevant videos being included in our submissions. The precision loss for our results may also be attributed to the different interpretation of relevance by the assessors or topic creators and by our test users as our users sometimes were more willing to accept a clip as relevant. This may just be the nature of the experiment in that we did not stress enough to the users that they should be completely sure of relevance to the topic before adding it as a result. It is also probable that our users thought that having some result was better than none so, they may have knowingly added results that were nearly correct.

Interface errors and interpretation errors may account for the loss of precision in the general search results but it cannot account for the far lower results in the known item search results. In fact, for 5 of the known item queries no correct results were found using the overlap measure at the parameter level 0.333, 0.333 – that is the precision and recall value was 0 (Topic 1, 27, 28, 29, 33). On inspection of our results it is clear that our users found correct results but they did not enter the start time and end time strictly enough and did not segment adjacent results into separate results. For example, for topic 1 our system 1st result (10 seconds long) overlaps 3 of the known item results but under the overlap measure even at parameter values 0.333, 0.333 none of the 3 known-items are attributed as matched (.5, 3, 2 seconds intersections respectively). Since the current overlap measure does not take into account other known items overlapping the results item when calculating result item coverage ratio it is unforgiving when a user has specified a single result that contains temporally close known-items. Some of the known items are less than a second apart (0.5s in Topic 1). The test users without prior explicit direction may interpret known-items in adjacent shots as one result.

Even without the multiple known items in a result issue the precision at which our users specified the results was to seconds. Often users specified results with more than a couple of seconds padding before and after the known item. For a known item of small duration the results item coverage would be very small and therefore it may not be found relevant at result item overlap coverage of 0.333 or greater. In Topic 1 alone two known items are 0.5s long and another is 0.6s long. If our test users had the facilities to segment and refine their results to more exact timing than to seconds the results would be considerably improved. Of course, we should also have stressed to the users during the experiment that they should only add the maximum relevant continuous camera shot segment that matches the topic.

Our results show that our known item results are slightly more sensitive to known item coverage than to result item coverage, but the difference is not great. The majority overlap measure degrades into intersection for situations where there are only two overlapping results (Section 2.3). If the overlapping results are both covering two different but temporally close known items, then the intersection will be covering neither. This may account for why our experiment is more sensitive to known item coverage. Perhaps, the overlapping measure should be changed to start point calculated as the mid point of start points and end point calculated as the mid point of end points of the two overlapping results in this special case of only two overlapping results. But even still this would result in a single result that probably only partially covers the two known items. And with the current metric even at the 0.333, 0.333 parameter level no known item may be matched. It may be even better to replace the majority voting method for overlap to one of average start time and average end time. These are all issues which we need to address in the near future.

3. Shot Boundary Detection

The Shot Boundary Detection system we evaluated in the video track makes use of the compression features of MPEG encoded video. This was done in order to achieve performance with a minimum of processing requirements as the decoding of MPEG video sequences is relatively time consuming and in areas where speed is an issue, compressed domain processing can offer high accuracy in a fraction of real time.

The MPEG video standard [LeGall *et al.* 96] achieves compression by exploiting the data redundancy present in video sequences. As Shot Boundary Detection is a temporal segmentation of a video sequence, the temporal compression features of the MPEG video standard can be used to help the Shot Boundary Detection task. The macroblock is a primary element in the MPEG standard and has a determinant role in the temporal compression of the video. The following considerations have been used for our Shot Boundary Detection:

- In general for most B frames a video encoder will trend to favour bi-directional predicted macroblocks in order to achieve better compression.

- B frames tend to use preponderant prediction from the nearest reference frame. Thus in a *group of pictures* with RBBR encoding pattern (where R denotes a reference frame and B a B frame), first B frame would have dominant prediction from first R frame and second B frame from second R frame. That led to a bigger number of forward predicted macroblocks than backward predicted macroblocks in first B frame and opposite for second B frame.

If a macroblock distribution in the currently evaluated frame sequence does not comply with the considerations above it is highly probable that a shot boundary has occurred and the changing of the dominant reference frame would designate the exact position of a shot boundary. An increase of the intra-coded macroblocks in the P frames may indicate a possible gradual transition.

It is evident that the files from Shot Boundary Detection test collection for the video track come from a few distinct encoding sources and it likely that we will have similar content and video coding effects within files provided from the same source. Therefore, because of resources available to us at the time, it was not considered possible to carry out an evaluation over the entire collection. For evaluation we selected a set of five representative files, one from each source, regarding as representative the file with the longest playing time within each source or the file which apparently contains more or more complex, shot transitions. Furthermore, as our Shot Boundary Detection system is based on video compressed domain features, characteristics of the video encoders such as image size, frame encoding pattern and the encoded macroblock types, were considered in order to select various encoding parameters. Our official results are presented below in Table 4 for all transition types.

Table 4: Shot Boundary Detection performance figures for 5 files from the dataset

Files \ Metrics	**Reference transitions**	**Deletion rate DR**	**Insertion rate IR**	**Precision Pr**	**Recall Re**
ahf1.mpg	107	0.158	0.074	0.919	0.850
anni009.mpg	103	0.708	0.009	0.967	0.291
bor03.mpg	237	0.573	0.050	0.893	0.426
ldoi874a_s1_02_004.mpg	7	0.00	0.142	0.875	1.00
nad28.mpg	298	0.221	0.050	0.939	0.778
Weighted column mean		0.386	0.049	0.925	0.613

Our Shot Boundary Detection work will be evaluated on the full dataset at a later time and our results above are not directly comparable to the results of other TREC track participants. However, the most interesting part of the work we report above is the computation time taken; running on a 733 MHz Pentium III PC with 256 MB RAM running Red Hat 7.0 Linux, the 76 min 39s of video took 4 minutes and 2 seconds of computation time, about 5% of real time.

4. Conclusions

Our results for general search topics and known item topics show two very different results for precision and recall even though both sets of topics were performed under the same environmental conditions. Indeed, our users were unaware of the query types when performing the search tasks for each topic. Adjusting the metric used in the known-item search to account for our particular “flexibility” in determining the start and end of clips identified by users, will be necessary and will be done post-TREC. We will also experiment more with different ways of collating independently gathered results into one non-overlapping ranked results list. The current method may not be one of the best but without further experimentation this is but guesswork. Further study of our results for individual users and of the browsers will be conducted.

References

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