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ABSTRACT

INA, the 'Institut National de l'Audiovisuel' keeps records of national TV and radio production as French patrimonial archives. They are mainly accessed by specialists for research purposes, and by TV producers for inserting archive segments within new productions. INA and several other partners have initiated an R&D project, OPALES, to develop a distributed environment, which enhances experts' private work on multimedia archives and enables collaborative knowledge work on the Web. The challenge is to advance knowledge by building digital communities of experts who add value to the archival dataset by annotating items. The environment supports users working on multimedia archives, preserves their data in private workspaces, and helps them to share expertise. Each end-user accesses information within a private workspace. Any document (annotation as well as archive) is handled as a private copy, which can virtually be annotated, indexed, linked to other information, edited to be inserted into new documents, and so on. Direct anchoring of annotations within audio or video is supported. To manage information and knowledge sharing, OPALES introduces the notions of an "authoring point of view," which identifies annotation categories and of a "reading point of view," which specifies which categories of annotations a reader wants to see. This paper presents the features of OPALES, describes the mixing of points of view on video archives, and discusses some issues raised by knowledge sharing among experts. (Contains 13 references.) (Author/AEF)

OPALES: An Environment For Sharing Knowledge Among Experts Working On Multimedia Archives

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INA and several others partners have initiated an R&D project, OPALES, to develop a distributed environment which enhances experts' private work on multimedia archives and enables collaborative knowledge work on the Web. The challenge is to advance knowledge by building digital communities of experts who add value to the archival dataset by annotating items. The environment supports users working on multimedia archives, preserves their data in private workspaces, and helps them to share expertise. Each end-user accesses information within a private workspace. Any document (annotation as well as archive) is handled as a private copy which can virtually be annotated, indexed, linked to other information, edited to be inserted into new documents, and so on. Direct anchoring of annotations within audio or video is supported.

To manage information and knowledge sharing, OPALES introduces the notions of an 'authoring point of view' which identifies annotation categories and of a 'reading point of view' which specifies which categories of annotations a reader wants to see. Any added piece of information always has an author and an 'authoring point of view.' To enable knowledge sharing, any user can 'export' a point of view to make some part of the elaborated knowledge available to others. Exporting a point of view consists of indexing it into the shared ontology to enable other experts to retrieve it easily and import it into their workspaces. A 'reading point of view' defines how a document is enhanced by annotations when presented. It is a mix of imported points of view. For instance, a researcher on sociology may 'import' ('borrow') the knowledge previously elicited and exported by economists, politicians, ethnologists, and so on, to better understand a document or to improve the relevance of queries. The selected annotations and links are displayed with the document. To enable computer activity using shared information, the system provides a mechanism for handling an extensible ontology, including point of view dependant aspects. It provides support for indexing and for searching in annotated documents.

The paper presents the features of OPALES, describes the mixing of points of view on video archives, and discusses some

issues raised by knowledge sharing among experts.

Keywords Video annotation. Video indexing. Private workspaces. User communities. Knowledge sharing.

Introduction

This paper presents a national initiative currently underway in France to develop a new service at INA. It aims to support work on video archives. The expected result is a step towards knowledge creation through digital communities of experts exchanging their expertise and making their work available to others. Their common work improves knowledge of the archives, thus leading to added value.

This service relies upon three interdependent and integrated features:

- an improved information retrieval system, with more precise recall for most users
- private workspaces in which users work seamlessly with private documents, archives documents and annotations of their own or of other users.
- a computer supported collaborative environment which enables distant users who do not know each other, but have the same concerns, to cooperate and to share the result of their work.

The project is intended to apply mainly to video and audio archives.

The paper first introduces the context of the work, presenting the origin of the video archives and the project. Then the role of the Web in facilitating distant exploration and annotation of video is presented. The focus is placed first on the features available in private workspaces, then on the sharing of knowledge among users. The notion of point of view is described from both the author's and the reader's side.

Working on multimedia archives

Many projects deal with video archives analysis (Chang 97, Houghton 99). Very few rely on humans for such a task. For instance, the Informedia project at CMU (Hauptmann 95, Olligschlaeger 99) relies on automated approaches such as language recognition and image recognition to produce on line overviews of audiovisual documents. The OPALES project has a quite different purpose and strategy: it aims to enhance the relevance and the level of detail that already exist in the indexing, with added metadata contributed by users working on the video.

Video archive storage policy in France

The systematic collection of books by National Libraries is now routine. Most great nations keep a record of all of their published information in libraries, and already a part of this is available in digital libraries. By contrast, most movies, TV programs, and radio productions are still collected only by producers. As a consequence, this costly collection effort is often limited only to documents which have great value and a high probability of being reused, either frequently or within a short time. Often the cultural or the patrimonial value of a document is not the main

criterion in deciding on its preservation for the long term. Such behavior is explicable in terms of market economy, but it causes much of the history of the audiovisual life of the country to be lost. Therefore, in the future it will not be accessible to researchers studying the evolution of our society. This is why France enacted a law in 1992 making it mandatory that any information producer deposit all published production into a specialized national institution: the Bibliothèque Nationale de France for printed documents, the Centre National de la Cinématographie for films, and the 'INAThèque' of the Institut National de l'Audiovisuel (INA) for audiovisual production broadcast on TV or radio.

This policy for audiovisual archives is even older, although it was initially limited only to the production of national TV. INA was created in 1975 to store the archives of national channels and make its collection available to producers and researchers. At the time of its creation, it inherited all the archives of the earliest national broadcasting company. It now deals with more than one and a half billion hours of TV and radio and more than one billion still pictures stored on more than fifty miles of shelves. Currently INA has started to convert a part of its collection to digital format; about 300 000 hours of radio and 200 000 hours of TV are completed, making it now one of the largest repositories of audio-video archives (Auffret, 2000). Nevertheless, note that INA is just the archivist, not the copyright owner of all the deposited documents. It often just operates as a central clearing house between buyers and information owners. Most of its services are related to indexing and searching for relevant information in this huge quantity of audiovisual data.

INA as a service provider

In addition to its storage function, INA is also in charge of promoting cultural heritage by proposing many services to clients. Basically, INA serves as a patrimonial archive. Archives are accessed mainly by specialists; for instance, by TV producers wanting to insert archive segments into a new production: perhaps a brief recall of historic facts within the news. Also, it is well known that journalists use archives to prepare and maintain biographies of most famous people, ready to be broadcast within a few minutes whenever needed. Documentary film series also take advantage of INA's archive.

One less visible application concerns the study of our cultural heritage. Many domain experts (historians, sociologists, economists...), and even teachers, novelists and movie producers study audiovisual archives for research purposes: to better understand some events, to elicit their relationships, as well as to catch authentic tiny details of a past way of life in order to produce more realistic stories. These people typically are the target users of the new service developed in the OPALES project. It is now a challenge for INA to take advantage of the Web to provide better service to these users in order that the institution, as a whole, benefit from their work.

The OPALES project

In fall 1999, the French Ministry of the Economy initiated the OPALES project within the PRIAM national R&D planning program. OPALES is an acronym for 'Outils pour des Portails AudiovisueLs Éducatifs et Scientifiques' (i.e.: 'Tools for Audiovisual Portals for Education and Science'). Project evaluation is scheduled during the fall of 2001.

OPALES aims to develop a distributed environment which boosts private expert work on multimedia archives and provides support for collaborative knowledge construction on the Web. Several institutions and research labs and an industrial partner participate in its elaboration and evaluation. The final system is not specifically dedicated to INA: some similar institutions dealing with patrimonial archives are interested in it and collaborate in the project. The MSH 'Maison des Sciences de l'Homme' in Paris, the 'Cité des Sciences et de l'Industrie', the CNDP 'National Center for Distance Learning', and the BPS 'Program and Service Bank' of the 5th TV Channel, as well as INA, provide both video archives and expert users to work on them. In the first experimental stage of the project, the corpus has been limited to copyright free documents in order to make experimental work cheaper.

The OPALES project and the Web

OPALES is a private Web portal, open only to registered users. Currently, access is restricted to project staff. It supports expert users' activities when working on multimedia archives, preserves their data in private workspaces, and helps them share expertise. Each end-user accesses information within a private workspace. Any document (annotation as well as archive) is handled as a private copy which can be virtually annotated, indexed, linked to other information, edited to be inserted into new documents, and so on. Direct anchoring of annotations within audio or video is supported. Elicited expertise may remain private in one's workspace or be shared. A shared ontology, coupled with indexing and search techniques (Chein 98) based on conceptual graphs, is used to handle semantically rich annotations.

Overview of private workspaces

Exploring video archives on the Web

Until now, end users working on INA's video archives needed to look physically at videotapes, either in the INA building or in their institution using purchased copies. Digital video on the Web and secure transactions now make it possible for the users to work from anywhere and for INA to drastically reduce access costs. A large part of users' work online consists of querying the archive base and then exploring retrieved video sequences to decide which parts are the most relevant. Efficient online work requires fast response time, something which is not currently a strength of video on the Web. Therefore, it has been necessary first to develop specific tools to enable rapid searching of video. Typically, users need to look quickly at video contents and explore them at variable levels of detail, not simply to *play* parts of the videos. Video players are not relevant for this service because they are designed for playing, not for exploring. VideoPlayer or QuickTime rely on stored video: they support immediate seeking, but on the Web, their use is restricted to very short movies. RealPlayer uses streaming. It allows playing a portion of a video before receiving its entire contents. It is well suited for live video on the Web, but does not provide real-time exploration features. Video summaries like image albums enable rough overviews but are not sufficient for exploring videos at a detailed level. A special 'videoExplorer' tool (Nanard, 2001) has been designed and developed at LIRMM in order to minimize information transmission between the server and the client station. The explorer server quickly delivers on-demand computed short overviews of any part of a video at any level of detail. A very simple interaction method is used to seek the

overview from the client station and select new segments to explore. This technique enables users quickly to observe videos at any level of detail and to focus on any relevant part, as precisely as at the frame level. Its external appearance and interaction method is very similar to that of a video player.

Working in private spaces on the Web

OPALES provides its users with support for private workspaces. One of the expectations of the project is to induce a feeling of ownership in users' work in order to attract clients, keep them, and make it harder for them to go on working elsewhere. In contrast to most Web sites and portals which enable either passive reading of documents or creation of private sites, OPALES supports active reading of documents. Active reading consists of directly working on documents as if they were private; for instance, directly annotating or editing them. In an active reading environment, the reader does not distinguish between interacting with an archival document and interacting with private notes. Such annotation features are proposed in many systems, but very few are actually effective.

In OPALES, any document displayed on the user's screen is always a virtual private copy. When a user selects a document to be displayed, automatically the server brings back both the document itself and all the references to the annotations previously attached to this document by the user, plus those explicitly imported, in context, from the shared knowledge bank. Since annotation contents are first class objects, they are handled exactly like other documents. One can annotate annotations at will, thus inducing a private hypermedia structure over the set of documents.

Users can also prepare private documents, including edited segments from archives. For instance, suppose a history teacher prepares a course, including in it selected relevant archival sequences as illustrations, with private comments added on the sound track and with some minor graphical enhancements such as indicating names of persons directly on images. Such documents are handled in OPALES simply as edit lists dynamically interpreted when displayed. They are rebuilt from the archives at playing time. Thus any annotation of the included segments anchored in the archives becomes available also from the private document, including notes created later.

Users can also flatten documents to use them outside of the OPALES environment, but in this case they lose all links to the OPALES environment. Flattening a document also triggers the evaluation of the copyrights of included archival segments.

Annotating documents and videos

An annotation results from an explicit user action. One 'annotates' a document by linking to it metadata that we call the 'annotation contents'. In essence, an annotation references the annotated document. Annotations as such are described separately from the annotation contents by a RDF descriptor. There is no restriction on the nature and contents of the annotation or on the annotated document. Anchoring can be done into the annotated document. Internally it uses an Xpointer notation (http://www.w3c). Anchoring into video documents internally relies upon a very simple SMIL description (http://www.w3c) of archival

movies that just takes into account the actual segmentation that occurs when indexing the archive in the database. All of the precise anchoring is expressed as time-coded segments, enabling anchors to overlap where there is suitable enabling stratification (Smith 92) of annotations.

It is important to note the asymmetry introduced in OPALES by using hypermedia typed links. By nature, annotation links are different from other links. A link to a document is not necessarily an annotation link. For instance, it may just be a 'citation' link. Annotation links result from a user explicit annotation action which internally creates the RDF descriptor and registers it in the database. Navigation links are handled in a more classical manner. For instance, the annotation contents can be an HTML document with links to other documents; such links are not considered as defining annotations since they do not result from an annotation action.

Annotations are objects in the sense of OO programming. Specific editors are available for each class of annotation. Among them, on the simplest side, a simple text editor or a XML/HTML editor enables users to produce documents; at the opposite extreme, a specific NCG 'Nested Conceptual Graph' editor enables users to attach semantically rich and computable (Mugnier 2000) descriptions of documents as indexing annotations.

Overview of knowledge sharing in OPALES

Interest in private workspaces would be very limited if they did not communicate. Therefore, the most important aspect of OPALES is its support for knowledge sharing among user communities. It enables any users to export part of their work and to import into their own workspace exported parts of other users' work. The OPALES basic belief is that the more shared metadata bound to a document, the greater the value of that document to users. Typically, exporting and importing annotations provide mechanisms for sharing knowledge and thus eliciting shared knowledge

Lesson learned from the Web

The Web currently is the largest shared information structure in the world. Studying the evolution from the poorest HTML1 to the XML based language family provides a rich set of lessons.

The most important requirement to enable large-scale collaboration is rigorously to define a simple but powerful shared language, and then support its extensibility. Lack of rigor quickly leads to the Tower of Babel phenomenon. Paradoxically, limited power of expression of a language combined with a lack of extensibility produces the same effect. Simplicity, precision and extensibility are required to enable large-scale collaboration.

To accommodate this observation in knowledge sharing , OPALES provides its users with a very precise but extensible ontology (Gruber 1993, Staab 2000), and with very simple rules to support its evolution. An 'archive' ontology is provided to define precisely all of the vocabulary used in the actual indexing of archival documents. But OPALES aims at capturing new expertise that, by nature, does not yet belong to this ontology. Therefore, it is necessary to provide mechanisms to extend

the ontology at will. This is not an easy task; it is even an extremely risky one. The chosen solution relies on 'private and sharable' extensions of the ontology.

Since any extension of the ontology and of the document indexing remains private, it has no consequence on the archive base and cannot introduce messy structures that would be troublesome for other users. On the other hand, if a subgroup of users trusts a given set of extensions, they can use it as a dynamically shared extension to the ontology, just for themselves. The OPALES knowledge-sharing engine enables users to work with dynamically extensible ontology and indexing of documents.

The notion of 'point of view' in OPALES is the key for dynamically managing private and shared extensions, indexing, and annotations, and as a consequence, for building and managing digital communities of experts who add value to the archive.

The central notion of 'points of view' in OPALES

Since OPALES is a private workspace strongly dedicated to supporting digital communities of experts, the management of dynamically evolving virtual communities is a major component of the system. We have chosen to permit the free creation of communities and free access to them. A user may create a community just by specifying a concern. We call it a 'point of view'. That user just has to write an informal document to define the concern and to index it formally in terms of the shared ontology.

In OPALES, any piece of information has a descriptor which identifies its 'point of view'. A point of view is not at all an index of the document, but rather a mark that denotes which category of users might be concerned with this information. Points of view have some weak similarities with 'newsgroups,' but it would be erroneous to push the metaphor too far. For instance, consider annotations of a politician's speech: one user may annotate it from an 'economist's point of view' evaluating long term consequences; another may do it from a 'rhetoric expert's point of view' discussing the speech structure; whilst yet another may focus on details of hand motion and face expression from a 'psychology expert's point of view'. Other psychology experts could be interested in retrieving documents annotated by colleagues in their virtual community. By declaring an annotation with this point of view, the annotator locates it within the concern of this virtual community.

Points of view induce an *a posteriori* classification of users based on their stated concerns. Tagging each piece of data with the author's point of view implicitly defines a partition of information spaces. It is stored in the 'workspaces' database. There is no need to use a partition since the formal indexing by points of view enables the NCG search engine (Chein, 1998) automatically to determine the location of the point of view, especially its specialization (Mugnier, 2000)

A point of view is either private or public. A private point of view makes sense only for its owner. It can be used as a kind of private classification system, with a personal vocabulary. A point of view becomes public if its owner 'exports' it, making its description and indexing visible to other users. As a consequence, public points of view are retrieved like any other documents, thus enabling users to be aware of declared public

points of view that are close to their concerns.

Using points of view is quite simple. Any editor window is assigned a default point of view which tags any new document created in this window. The user may assign to it any other point of view, private as well as public, retrieved either from a favorite point of view list, or from a search of existing ones close to the query. If no point of view matches the query, the user may create one and export it: the query already is a good base for starting to index the point of view. It just has to be informally described more precisely. Since points of view are attached to the window rather than to the user, one may easily handle several points of view, private or public, in a workspace.

Since all pieces of information have a point of view, any extension done to the ontology also has a 'point of view'. Extensions can be private or public. In this case, other users can share it. OPALES also supports regulation mechanisms for points of view, especially 'moderator approved points of view' that are suitable for asserting the consistency of extensions done to the ontology.

OPALES points of view have been designed to enable knowledge sharing. Any displayed document has a 'reader point of view' that specifies enhancements by annotations, indexing, ontology extensions, and so on. The readers' point of view is distinct from the author's, since they may also enjoy reading information stored with other points of view to get a wider understanding of a document; but the readers have no reason to place any writings in such points of views. They read from a point of view that combines several authorial points of view, but write from their own. For instance, let us suppose that a sociologist studies the speeches of a politician in order to write an essay on 'tricks to convince crowds'. This user would benefit from importing into the workspace the points of view of the 'psychologist expert' who has analyzed the details of hand motion as well as those of the 'rhetoric expert', but has no reason to write in those points of view if the user's current writing does not concern these virtual communities.

Any window has a 'reader's current point of view' that is built as a list of imported points of view. When a document is delivered in this window, the system also delivers and displays the document's list of *public* annotations that have been created in the points of view currently included in the reader's point of view. .This enables users to browse any of these annotations and recursively annotate them.

The reader's point of view also acts on the search engine. First, during the query preparation, it filters and expands the ontology to help the user choose the proper vocabulary. Second, the search engine takes into account both the actual indexing done on archive and also any public indexing done with the points of view included in the reader's current point of view. This enables both writing far more precise queries which are domain dependent, and retrieving very short segments matching such queries, since annotations can be anchored freely and precisely into the video archives.

Museums keep track of our history and culture. The Web can help them make the past available to all. The most important thing is not simply to show remarkable crafts, but to make their impact on our culture understandable. Museums are like icebergs; the part of collections made visible is rather small. Museums also preserve huge and rich material in

storage, but in most cases, it is poorly used and difficult to study. This typically is the case with huge amounts of digital information that contains a quite continuous record of our social evolution. Paying museum staff to exploit these resources efficiently is far beyond museum budgets. Other solutions are needed. OPALES is one of the solutions. It relies on collaborative work on the Web.

Beyond the well-known role of the Web in information access, a far more important application domain is emerging: collaborative and distance work. The effectiveness of Web users' work is now greater than most analysts of the last decade could have imagined. Breaking encryption keys that were supposed to require mainframes for centuries of work has taken months owing to the shared distributed power of home computers. Dealing with freely distributed collective knowledge is a great challenge for the new century. The Semantic Web project initiated by Tim Berners-Lee (Berners-Lee 1998) bets on the power and efficiency of freely organized collaboration. Several other initiatives propose techniques for distributed annotation of Web pages based on a RDF schema, to improve the efficiency of search engines (Kahan 2000). On a smaller scale, OPALES bets on mixing distributed work within a centralized environment. The choice depends on the need for a well-balanced solution. Letting users do freely what they want has obviously been a success with the Web: a reliable structure has slowly emerged. But in smaller environments, this strategy lacks statistical regulation mechanisms, so it is known to run out of control easily. Constraining users in order to enforce controlled structures requires external force. It never works in open environments. The solution is a balance in which users both feel free but easily find attractive clusters where their expertise is recognized and can be cumulated with others.

The point of view mechanism in OPALES is easy to use. It is sufficiently free to allow everyone to use it at will, without any regulation mechanism. But by its nature, it leads to the formation of virtual user groups within which knowledge can be elicited in a consistent manner, relying on small and local extensions of a shared ontology. This feature enables people working on the same topics to cumulate their efforts. Furthermore, the 'reader's current point of view' provides the means to trigger interdisciplinary work by importing knowledge from other domains for better understanding.

OPALES currently is a tool for experts, mainly because exploring the storerooms of museums is not yet for end users. But expert work has results which usually are presented to end users. Currently the corpus chosen to bootstrap OPALES contains, among others things, a rich collection of documents about the history of modern mathematics, especially hundreds of hours of records of work meetings of the Bourbaki group. As an example, exploring and annotating these historic documents will benefit the 'archaeology' of science by providing a better understanding of the evolution of this discipline, and will make these enhanced documents accessible to a larger audience.

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