Visual String of Reformulation

Arne Berger, Jens Kürsten, and Maximilian Eibl

Chair Media Computer Science, Technical University Chemnitz,
Strasse der Nationen 62, 09107 Chemnitz, Germany
{arne.berger,jens.kuersten,eibl}@informatik.tu-chemnitz.de

Abstract. An interface for query reformulation based on multimedial search widgets is proposed. It allows the co-existence of widgets for unambiguous intellectual metadata and vague, automatically annotated metadata.

Keywords: customization, interface, multimodal, query reformulation.

1 Visual String of Query Reformulation

The interdisciplinary project SACHSMEDIA conducts research on automatic audio, image and video annotation, high-level semantic metadata, and a user-centered interface approach for combining the above in one information retrieval system. SACHSMEDIA is a joint project of Technical University Chemnitz (Germany), selected solution providers for television production workflow, as well as local TV stations in Saxony (Germany). The project is financed by the Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung).

Our work reflects the information retrieval needs of those TV stations for their growing multi-media repositories, as well as an incorporation of the constantly growing opportunities arising from automatically annotated metadata. This paper summarizes the efforts undertaken to form a fully customizable, user-adaptable text-based retrieval interface based on widgets, reflecting the TV stations' needs for a clean and fast multi-media search interface. It also incorporates graphical search widgets for retrieval based on fuzzy automatically annotated metadata, for evaluating the later under real working conditions and for supporting a more open searching/browsing approach. Our aim is to bridge three gaps in modern information retrieval graphical user interfaces:

1) Heterogeneous user population
Text-based retrieval suits many users fine, as daily work usually consists of known item searches, for which textual interfaces are sufficient. However, as the user population is heterogeneous, customized search interfaces improve user satisfaction significantly.

2) Modal gap
Plain text-based retrieval is not sufficient for all emerging tasks. It leads to user frustration and confusion, as it requires the user to repeatedly switch their mental

M.J. Smith and G. Salvendy (Eds.): Human Interface, Part II, HCII 2009, LNCS 5618, pp. 239–248, 2009.

model while refining and reformulating a query. Current multi-media information retrieval is the iterative task of searching, browsing, then editing the query for refining, then browsing. We propose an interface model for searching and refining in order to reduce this modal gap.

3) Content based retrieval approaches
We propose a solution for merging information retrieval concepts for multiple media. From a user perspective, there is an out-dated paradigm that automatic audio, image and video annotation, content clustering and ontology browsing reside in separate interfaces. We offer a conceptual model to overcome this by implementing distinct retrieval approaches into one retrieval interface.

2 What End Users Do (And Don't Do)

The design view
User studies and user evaluation are essential in HCI, we learn. But then, a mere "thumbs up" from a small percentage of a proposed user population is usually sufficient for a product to get a go for implementation. This kind of interface evaluation is the reason why so many interfaces fail to give the feeling that it "fits" like a custom tailored suit. Even worse, software nowadays often succeeds in giving a feeling of comfort, by crippling the softwares' possibilities. While Maeda's design approach [8] is groundbreaking for tailoring usable software that fits for large user groups, it still lacks the flexibility of a custom tailored interface, deriving from an in-depth user understanding, and resulting customization. [4], [6]

What end users do (and don't do)
The end-users we work with are professional researchers, editors and account executives at German TV stations. Every TV station annotates and archives their own footage for later retrieval. Those archives are constantly growing, containing multimedia data that is poorly intellectually annotated and fully lacking high-level semantic metadata. Our research purpose is to support end users with interfaces for easier annotation and retrieval, focusing on encouraging them to add more intellectual metadata when adding footage to the TV stations' archives. Additionally, the archive software must be suited to all (about 70) involved TV stations for later connection and interchangeability. The metadata scheme that we applied is "Regelwerk Mediendokumentation" (system of rules for media documentation from ARD) [20], comprising of 70 metadata fields for annotation of intellectual metadata.

Extensive site visits and user studies at seven selected TV stations showed a lot of insight: To start out, we found out that many users are involved in creating an individual program, but they differ greatly in their knowledge about it. But no user involved has the time or the skills to collect all metadata from all involved users and add those to the archive. We studied in depth how the TV stations handle their annotation and search tasks. The following example is prototypical for the distribution of knowledge between individual users.

One user was asked to find an individual program. The user shared an office with three co-workers and began to voice her associations with this program. Someone in

the office remembered that the production in question was commissioned. This prompted the account executive to browse the account book for the client in order to approximate the date of the program. There had been only two commissions by the client in the last two years. This information allowed the editor to search all the tapes from the time in question, tracking down the tape and using the label to find the program's position on the tape.

As the users are all aware that their archives are poorly annotated and wish to change it, they are willing to contribute their knowledge about the productions they are involved in for annotation.

Based on the findings of the site visits an annotation workflow like this is plausible:

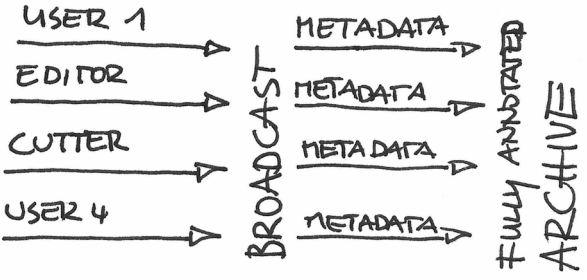

Fig. 1. Annotation Workflow

For our first annotation & retrieval prototype, we examined the three main user groups at the TV stations and asked them to sort all those 70 metadata fields that are searchable and may be annotated, according to a) their relevance for the single user's information needs and b) into metadata sets (groups) of thematic coherence. Not surprisingly, the output showed significant patterns in information need, the metadata selected and the user's engagement in the broadcasting process.

Structured qualitative interviews showed that users are willing to annotate more metadata when the annotation interface reveals only those metadata for annotation that are relevant for the user's current involvement in the production cycle. Additionally, users were likely to add more production related metadata than already included. Account executives, for example, have been keen to add additional metadata to Regelwerk Mediendokumentation. As they tend to remember names of people in the footage more, they demanded complete customer contact information as metadata for the single programs. Concluding this, we decided to sort metadata fields into the proposed sets and offer an option to add sets with additional metadata according to the TV stations' needs. This allows every user to get their own metadata annotation sets according to their production involvement. The annotation tool was structured accordingly.

Going back to the associated search example at our site visits, properly annotating intellectual metadata was only part of the problem. A second finding of the site visit is that users are highly interested in customizable retrieval interfaces according to their different information needs. The information need usually lies somewhere between

the quasi-standard one query input field approach on the one hand, and an expert search interface with around 70 input fields and adequate combination options for a search in all available metadata fields that are annotated, on the other hand.

Using two iterations of paper prototypes, we tested whether an interface for retrieval that was structured similarly to the annotation interface would also enhance user satisfaction. Users instantly made a connection between the annotation and retrieval tool and wanted to use the customizable retrieval interface accordingly. A quantitative comparative evaluation of the performance of our interface versus an ordinary expert search will be conducted at a later stage, but interviews look promising.

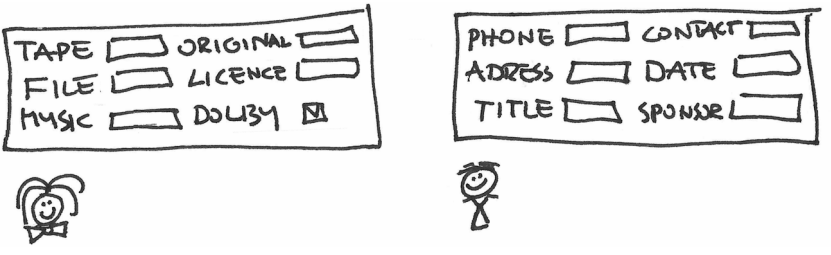

Fig. 2. Custom Text Widgets

3 Content-Based Retrieval

Based on the finding that widgets suitable for only a small, distinct task are helpful for a step-by-step query specification and reformulation, we expanded this idea to multi-media query formulation. This makes sense in two ways. To begin with, users told us they are constantly in need of better search results, mostly because intellectually annotated metadata are not sufficient. Secondly, users are looking for less restricted ways to formulate queries in their daily work. They are aware of automatically annotated metadata, the chances they offer and the drawbacks they currently have. Users are willing to sacrifice their current fixed text based retrieval systems for a more open way to formulate queries. They are also willing to sacrifice some precision at first – if they are allowed to refine their queries using other widgets at hand when it becomes necessary later on.

The above findings of high user acceptance enable us on a technical side to enhance the TV stations' archives with rich high-level semantic metadata without compromising the users' faith in the retrieval engine. In the SACHSMEDIA project, we are attempting to solve the recognition of persons via facial and voice recognition, to be included in the retrieval system. However, it is also plausible to include previously solved parts of our research findings in distinct widgets. Those steps include OCR in the lower third of the screen or automated detection of the presence of persons. It is plausible to include those examples as widgets in a retrieval system, but they alone would not automatically justify a stand alone application.

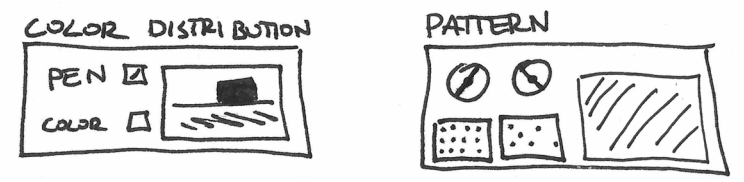

Fig. 3. Graphical Widgets

In the information retrieval community, a lot of search engines based on high level metadata are used that are helpful in many ways for distinct retrieval tasks, but are – in and of themselves – not always sufficient for sophisticated search tasks in a professional work environment. Formulated in widgets and combined in a query formulation and reformulation flow, they would be much more useful. There are sketch-based image search engines like “retrievr”, or engines that focus on drilldowns in content clusters such as “cuil” or “quintura”. Tools that feature image search based on the color distribution of the images includes “xcavator”. What is available for searching videos and music is text-entry only and includes “seeqpod” and “veoh”. [21], [22], [23], [24], [25], [26].

Unfortunately, there is a gap between what search applications are possible, and what search applications have already been combined in one interface, as most retrieval systems focus on just one issue. That is why we widened our user-driven approach to engage retrieval experts working on content-based information retrieval. We conducted qualitative interviews with those experts, and they all focus on only one of various different annotation and retrieval concepts which are insufficient to form a distinct search experience for a multi-media repository on their own. As the possibilities in analyzing image, speech and temporal features grow, our proposal can also be used as a model for creating distinct widgets. These widgets contain only those interface elements needed for one distinct query part, corresponding to one specific retrieval concept. Combining them into one search interface would significantly enhance the possibilities of information retrieval.

4 Reformulation

Search is an iterative process. This has been thoroughly discussed in, among others, the classical model [13] or the 5-phase framework [15]. The query is iteratively reformulated after an inspection of the results until relevant information has been found. There is a difference between direct and explorative search. Methodic search includes alternating search and browsing. I'm feeling lucky basically trusts the retrieval engine's first suggestion. Our approach focuses on the techniques most frequently performed in the work environment of TV stations: query reformulation and methodic search.

On the rare occasion that a user actually performs a known item search, a text-based query or query by example is sufficient. But most of the queries are so vague that users just hope to find something similar to their mental reference, needing to refine their query substantially. Typically, users start out with a short query and

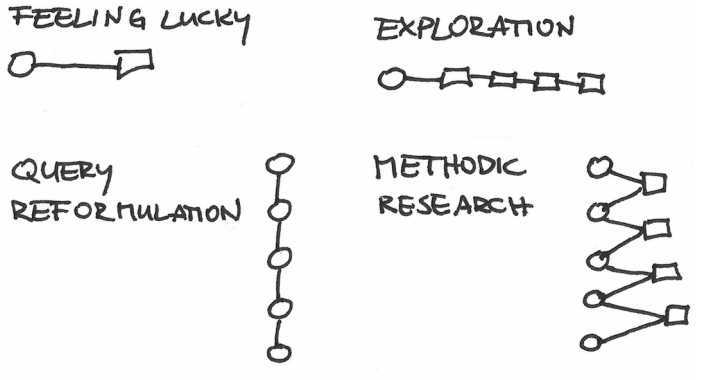

Fig. 4. Retrieval Tasks

incrementally modify their query after inspecting the results, slowly forming a string of reformulation emerging in their heads. The back and forth of re-editing the text-based query leads to an iterative modal break and obstructs the users' string of reformulation as previous versions of the text-based query are no longer present after editing. Moreover, there is no tool to visually memorize all the steps taken in the reformulation. Our proposed interface is based on a graphical metaphor for reformulating multi-media information need. It allows end-users to begin with an initial query, then to add more queries in the form of interface widgets in order to narrow down the search results, all while maintaining a graphical representation of the performed queries. This visual string can be edited.

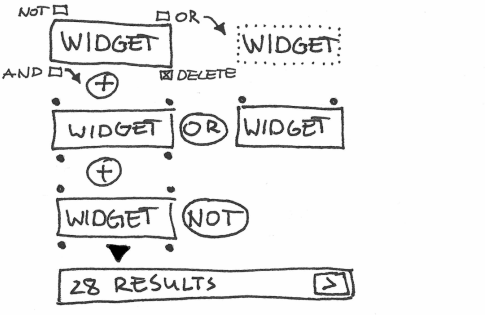

Fig. 5. Widgets & Flow Of Reformulation

We worked out a basic set of various text-based widgets based on users' needs. We also established design guidelines for producing interface widgets that adhere to our conceptual model. Textual widgets can be individually modeled based on a design styleguide and an XML schema. Additionally, we created graphical widgets built on top of the current research status at SACHSMEDIA for automatic multi-media annotation, and included those as well. This allows end-users to use the most appropriate search widgets for a step-by-step reformulation of their queries according to their needs.

Based on the rich possibilities of contemporary interface design for creating interactive widgets and a user centered customization approach, we like to advance the common filter/flow metaphors for open multimedia repositories, content-based metadata and unpredictable, vague queries. Shneiderman [16] proposed the metaphor of water flowing through filters for a visual representation of boolean query formulation. In his evaluation, users not familiar with Boolean algorithms, showed significant better search results and user-satisfaction compared to using SQL-syntax. However, Shneidermans concept was only applied for searching in closed databases with descriptive metadata. Repositories have grown ever since and most end-users still do not understand Boolean query formulation properly. Jones proposes Venn-diagrams [7] in a similar approach to visualize reformulation. With concepts like the Islands Interface [3], Sentinel [9] or InfoCrystal [18] the basic concept is too difficult for user acceptance. That is why expert search systems nowadays focus on more basic metaphors restricting users to more basic ways of query reformulation.

The mismatch between these two concepts still persists. Krause coins it like that: users don‘t want to think about how to interact with a system. On the other hand they insist to adapt to a predefined flow because it feels like narrowing their possibilities. [2] This is the reason we like to let users form their own flow as precise or vague as adequate, leaving it in the users hands to formulate simple or complex queries all within one conceptual model, expanding the visual string accordingly.

1. Widgets: According to Krauses model [10] every widget is conceptionalised as a tool with three capabilities or usage sides. On the users side the widget acts as the most suitable tool according to the users capabilities and knowledge and the query at hand. Although possibilities for interaction are pretty endless here, text based widgets may dominate professional work environments for a while. But basic content based retrieval widgets are already successfully implemented for distinct tasks and are helpful as query terms for reformulation. More complex widgets will be useful for more complex tasks and specific users. Developers and designer may create or customize widgets according to emerging user needs and technical possibilities. As the visual string is already evaluated as usable, distinct widgets may be compared against each other for user acceptance and usability. On its system side the widget transforms the text- or graphic based query to XML the retrieval engine can process. It also features a meta side for valuing its own capabilities (precision/recall) and dependencies (to previously submitted query terms).

2. Flow: Current retrieval interfaces lack any user accepted visualization of the query reformulation process. To visually formulate a multi term query, the widgets may be ordered next to each other. Our proposal lets users position widgets vertically below each other, to combine query terms for reformulation. Our findings show that when users drill down results by adding a widget in order to add another query term for reformulation, they expect widgets to be AND-ed when connected vertically, as single queries from within a widget are also AND-ed. Accordingly, a horizontally added widget will be interpreted as an OR. NOT is an option included in each widget to exclude its term from the query. Removing a search widget eliminates this query term. For a single term known item search users may just use one widget.

5 Discussion

From Objective to Subjective: We have discussed the everyday dilemma of heterogeneous user population, as well as the co-existence of unambiguous intellectual metadata and vague, automatically annotated metadata, and ways of handling these in a working environment. From a design-oriented perspective, this is more of an advantage than a drawback, as it demands less dualistic forms of interface design and evaluation.

From Quantitative to Qualitative: The mantra of the many right ways is a conceptual thread fundamental to this paper and demands an even deeper investigation. Building on top of what is currently being practiced as "qualitative evaluation" [6], we are categorizing scenarios that profit from users' subjectively ideal interfaces. On the other hand, we are also looking into ways to derive subjective instantiations to be integrated in more quantitative scenarios that usually focus on the "objectively good" interface.

Interpretation: It is the designer's job to support users in the interpretation of the system. [18] As the interface is the entry point to a search engine that provides exact and fuzzy results, it has to be interpretable and usable as such for the users. The designer's goal is not to propose a generic search interface that will fit most users and imaginable retrieval scenarios, but to create one that adapts well to different users and various precision/recall ratios, and the users' according expectations and interpretations. The interface therefore has to reflect the range of low level content analysis up to the highest level of sophisticated metadata for the users' interpretation. In this context, a more exact or more vague retrieval outcome has to be communicated. Interface design, incorporating graphic design to a greater extent, will help, managing the increasing complexity of usage scenarios as well as the problem of visualizing various retrieval outcomes.

Taking into account that different users and heterogeneous user groups will interpret different retrieval outcomes differently, the system has to communicate actively to the user its current state of helpfulness and therefore its skills. Users' feelings and demands have to be considered more carefully and in all phases of the project. That is: qualitative insight counts more than quantitative insight, as the system instantiates itself differently in certain stages and to different users. There is a range of possibilities offered by the system, and a range of interpretations. Both have to be considered for evaluation. The user interface has also to take into account that users' goals might differ significantly from task to task. It has to stay open for interpretations of what is searchable and how precise this could possibly be.

6 Future Work

With the future incorporation of context-aware interpretation of the users' knowledge and tasks, as well as the repository and its metadata, the blurring of what objective/subjective serves the information need, gets more apparent. Suitable ways

of analyzing tasks on micro, meso and macro layers [14] have to be found and applied for evaluation and for implementation of a recommender system.

Two more problems will be discussed in our future work. The next step is an evaluation in comparison to an ordinary expert search, assessing the users' thoughts on the quality of the retrieval outcome. Secondly, we are working on several ways of visualizing the retrieval outcome more efficiently and in a more inviting manner for browsing – in favor of another modal gap in need for closing. Multitouch interfaces look promising for that, as they may easily incorporate the current work on query reformulation and magic lenses as filters. Along with a more efficient and more usable result visualization, this will help users switch more seamlessly between the modalities typical for known item searches and explorative searches.

References

1. Bates, M.J.: The Design of Browsing and Berrypicking Techniques for the online search interface. Graduate School of Library and Information Science, University of California at Los Angeles (1989)
2. Bauer-Wabnegg, W., Krause, J.: Visualisierung und Design - Grundlagen von Softwareergonomie und Mediendesign. Universität Koblenz-Landau (2003)
3. Brooks, M., Campbell, J.: Interactive Graphical Queries for Bibliographic Search. Journal of the American Society for Information Science (JASIS) 50(9), 814–825 (1999)
4. Buxton, W., Greenberg, S.: Usability Evaluation Considered Harmful (Some of the Time). In: Proceedings of the ACM CHI 2008 Conference on Human Factors in Computing Systems. ACM Press, New York (2008)
5. Hearst, M., et al.: Finding the flow in web search. Communcations of the ACM 2002 45(9) (2002)
6. Ireland, C.: Qualitative Methods: From Boring to Brilliant. In: Laurel, B. (ed.) Design Research. The MIT Press, Cambridge (2003)
7. Jones, S., McInnes, S.: A graphical userinterface for Boolean query specification. International Journal on Digital Libraries, 207–223 (1999)
8. Maeda, J.: The Laws of simplicity. The MIT Press, Cambridge (2006)
9. Knepper, M.M., Killiam, R., Fox, K.L.: Information Retrieval and Visualization using SENTINEL. In: Proceedings of the Trec-7 Conference, pp. 393–397 (1997)
10. Krause, J.: Das WOB - Modell - Zur Gestaltung objektorientierter, grafischer Benutzungsoberflächen. In: IZ Sozialwissenschaften. Universität Koblenz-Landau, Bonn (1996)
11. Pangaro, P.: Design as I see it, `http://pangaro.com/design-is/index.html`
12. Pangaro, P.: Participative systems, `http://pangaro.com/PS/index.html`
13. Robertson, S.E.: Theories and Models in Information Retrieval. Journal of Documentation 33, 126–148 (1977)
14. Russell, D.M.: What are they thinking? Searching for the mind of the searcher. Invited presentation, JCDL (2007)
15. Shneiderman, B., Plaisant, C.: Designing the user interface. Pearson, Boston (2005)
16. Shneiderman, B., Young, D.: A Graphical Filter/Flow Representation of Boolean Queries. Journal of the American Society for Information Science 44, 327–339 (1993)
17. Sengers, P., Gaver, W.: Staying Open to interpretation: Engaging multiple meanings in design and evaluation. In: DIS 2006 (2006)

18. Spoerri, A.: InfoCrystal: a visual tool for information retrieval & management. In: Proceedings of the second international conference on Information and knowledge management, Washington, D.C, pp. 11–20 (1993)
19. Stempfhuber, M.: Towards Expressive and User friendly interfaces for digital libraries containing heterogeneous data. In: Eibl, M., Wolff, C., Womser Hacker, C. (eds.) Designing Information Systems. Festschrift für Jürgen Krause, pp. 198–208. UVK Verlagsgesellschaft mbh, Konstanz (2005)
20. Regelwerk Mediendokumentation, http://rmd.dra.de/arc/php/main.php (last visited, February 1, 2009)
21. http://labs.systemone.at/retrievr (last visited, February 1, 2009)
22. http://xcavator.net (last visited, February 1, 2009)
23. http://www.cuil.com (last visited, February 1, 2009)
24. http://www.quintura.com (last visited, February 1, 2009)
25. http://www.seeqpod.com (last visited, February 1, 2009)
26. http://www.veoh.com (last visited, February 1, 2009)