

Evaluation of MPEG-7 Audiovisual Query Applications

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Abstract— Accessing, searching, the information needed from multimedia database system became more important. Content-based retrieval and semantic querying applications use MPEG-7. Difference between traditional DBMS and MPEG-7 applications is the retrieving method.

In this project, we evaluate the interface and functions of audio and visual multimedia query applications which are based on MPEG-7, according to MPEG-7 query format requirements developed by MPEG.

This project represents different kinds of MPEG-7 multimedia applications, provides suggestions of design for the developers on the bases of evaluation criteria, and gives practical advice to the ISO standard documents.

Keywords— MBEG-7, XML, MARVEL, MIRROR, Sloud, SQUID

I. INTRODUCTION

The first phase of developing relative full functional and commercial Multi-Media Database Management System (MMDBMS), which provide a suitable environment for storing, using and managing multimedia data, began during mid-1990. The typical products of this phase include Mediaway [1] and JASMINE [2], both of which are able to select, insert and update diverse kinds of data. But now, most of them disappear in the market because of the rapidly changed hardware and software environments. The research of the second phase is the mainstream, and the market representatives are Oracle 9i and IBM DB2. They both adopt Object-Oriented Database Management System (ORDBMS) which provides the facility to define new data types and operators appropriate for the new kinds of media [3]. The MMDBMS working as an extensible system of ORDBMS manages image, audio, video and spatial objects in a common framework. The third phase emphasizes the content-based retrieval and semantic querying application which relies on Moving Picture Expert Group (MPEG)-7 standards.

The biggest difference between traditional DBMS and MPEG-7 applications is the retrieving method. Most traditional DBMS still prefers using keywords to query

multimedia database. That is, the keywords or textual abstract are the main indexers to describe the content of the media. The alternative is Content-Based Retrieval (CBR), based on the real content of multimedia data. One of MPEG-7 application characteristics is low-level retrieval.

II. THE MBEG-7

MPEG is a group at ISO/IEC (International Organization for Standardization / International Electronic Commission) that is responsible, since 1988, for developing the standards for coded representation of digital audio and video. There are a set of standards produced by MPEG. The first was MPEG-1, followed by MPEG-2, MPEG-4, MPEG-7, and MPEG-21.

These set of standards could be divided into two families, which are MPEG coding family, which contains MPEG-1, MPEG-2, and MPEG-4, the second family is metadata, this family contains MPEG-7 and MPEG-21.

MPEG-7, which is formally named “Multimedia Content Description Interface” [2], is standards developed by MPEG at ISO/IEC. MPEG-7 uses XML as a textual representation of content description. The location of the MPEG-7 data might be merged with the material; in this case MPEG-7 data might be in the same data stream or the same multimedia database system. Other alternative, MPEG-7 description data could be located some where on the Internet [6].

MPEG-7 provides a flexible framework and describes audiovisual data, so that it addresses different applications with different formats. Methods and tools for MPEG-7 are regrouped into eleven parts, ISO/IEC 15938-(1-11). Part1 (system) provides coding and terminal architecture. Part2 (Description Definition Language, DDL) which is the language for defining MPEG-7 tools. Part3 (visual) and Part4 (audio) are for the descriptive elements. Part5 (Multimedia Description Schemes, MDS) it is a description tool act with specific generic feature. Part6 (Reference Software) provides a software accomplishment of MPEG-7 relevant parts. Part7 (Conformance Testing) is a testing conformance procedure for MPEG-7 implementation. Part8 (Extraction and use of description) is a material that describes the abstraction and the usage of some of description tools. Part9 (Profile and Levels), supplies a guidelines profile. Part10 (Scheme Definition) specify the scheme using DDL. Part11 is the latest part of

MPEG-7 standards, which includes the real schema in XSD form for part9.

There are five elements of the MPEG-7 standards; these elements are DDL, Classification Scheme (CS), Extensibility, Description tools (Ds), and System tools. *Harald Kosch, 2004*, figures out the relationship between these elements, see Figure 1.

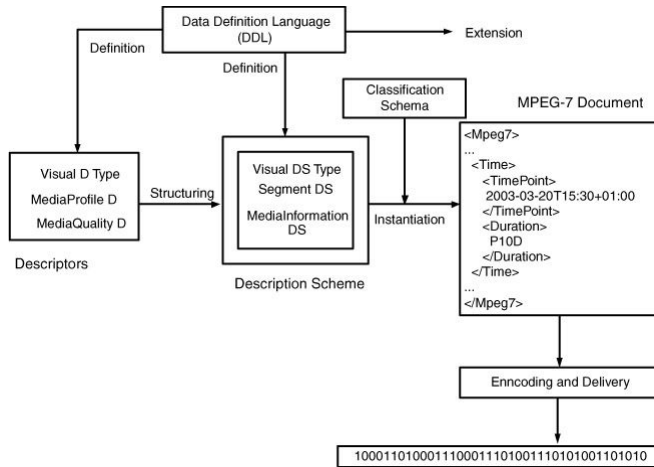


Figure 1. MPEG-7 main elements and their relationship [4].

A. MPEG-7 Description Definition Language (DDL)

MPEG-7 uses Extensible Markup Language, XML, and DDL based on XML schema. Here is an example of MPEG-7.

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<Video attribute="at_KTH"/>
<VideoTitle>Alaelddin in Sweden</VideoTitle>
</Video>

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XML Schemas “express shared vocabularies and allow machines to carry out rules made by people” [8].

MPEG-7 has specific extensions added to XML schema, which come from the problem that XML schema was not implemented particularly for audiovisual contents. DDL has three logical standard elements. These three elements are XML datatype, XML schema structure, and MPEG-7 extension to XML schema.

The Datatype XML schema is part2 of XML schema specification, its aim to define datatypes that are going to be used within XML schema to bind the datatypes of elements and attributes. Datatypes of XML schema provides a set of built-in primitive and derived datatypes, and a mechanism with which the user can define their own datatypes [8].

The structures of XML schema is part1 of XML schema. It gives easiness for describing the structure of XML documents. An XML document that is described by specific schema called instance document. XML schemas have four main features, which are simple and complex datatypes, type derivation and inheritance, elements occurrence constrain, and namespace-aware element and attribute declaration.

B. MPEG-7 Query Format (MP7QF)

The goal of MPEG-7 query format (MP7QF) requirements is to provide renovation on query language to query MPEG-7. MP7QF offers definition, notes, and examples for each related items. MP7QF regrouped into three categories. These categories are input format, output format, and query management tools. There is general requirement for each tool. Any category provides the following functionality.

- General requirement: provides general information about the application and its relation to MPEG-7 and XML standards.
- Input Query Format: Provides syntax and semantics for the interface between clients and servers for search criteria and return the data.
- Output Query Format: Provides the response interface from the server to the client. Parts of it are defined in the input query format.
- Query Management Tools: Support the required functionality to manage the query transaction between the clients and the servers. This includes the network protocols support.

In total, there are thirty-one detail parameters composing this criterion, which include almost every direction for this query format. MPEG interprets every criterion in detail in MP7QF requirement document. This project adopted the professional standard description as the evaluation criterion.

The evaluation criteria for MP7QF shall support as many mandatory requirements as possible. There are three degrees to support for each evaluation criteria, that are Full Supported, Partial Supported, and not support.

III. MBEG-7 AUDIOVISUAL APPLICATIONS

In the empirical work, we actually evaluate five MPEG-7 audiovisual applications. This section introduces these applications.

C. Caliph& Emir

Caliph& Emir (C&E) are MPEG-7 based Java prototypes for digital photo and image annotation and retrieval supporting graph like annotation for semantic metadata and content based image retrieval using MPEG-7 descriptors [21]. It is constituted of two parts. One of that is Caliph which is an annotation tool for selecting pictures. Another is Emir which is a query tool based on the annotation from Caliph. The latest version of C&E 0.9.23 which is released on July 31, 2006 needs to run on the Java 1.5. Meanwhile it is open source software that is able to detect the mistakes in an easy way and updates in time

D. IBM MARVEL

IBM Research is developing a prototype multimedia analysis and retrieval system (MARVEL) which is a system uses multi-modal machine learning techniques. MARVEL automatically annotates multimedia making it possible to later search and retrieve content of interest. The objective of

MARVEL is to help the media industry, including stock photo/video and broadcast companies, as well as libraries, organize large and growing amounts of multimedia content much more efficiently and automatically. The MARVEL is based on the MPEG-7 standard, which standardizes a number of content description tools that allow effective indexing and retrieval for video content.

E. MIRROR

MIRROR (MPEG-7 Image Retrieval Refinement based On Relevance feedback) is a platform for content-based image retrieval (CBIR) research and development using MPEG-7 technology [23]. MIRROR consists of three main parts: Feature Extraction, Similarity Measure, and Relevance Feedback. At the beginning, the system was developed for demonstrating the difference between the picture content descriptors.

F. Sloud Query-by-Humming Search Music Engine

Sloud Query By Humming (QBH) is a musical content-based retrieval system developed within the framework of the MPEG-7 standards [11]. In this system, songs recorded in a human voice then converted to MIDI, the search done by melody hummed into microphone, where the result returned into web-page.

G. Shape Queries Using Image Databases (SQUID)

SQUID system developed in Center of Vision, Speech, and Signal processing at the University of Surrey, United Kingdom. The system is image database retrieval on the internet that offers the possibility to user to submit shape as query objects. The database used for MPEG-7 evaluation of shape description.

IV. ANALYSIS OF THE RESULT

MPEG-7 query format requirements standard (MP7QF) is a great resource for developers in the field. The MP7QF have been adopted as our criteria to evaluate the retrieval applications. In the evaluation details, there are four parts. The first part General which has six different criteria, the second part is Input Query Format which has 18 criteria, the third part is Output Query Format which has only two criteria, and the last part is Query Management Tools which has six different criteria. The Evaluation parameter has three different facts; Full supported, Partially Support, and Not Support.

In Figure 2 we combined Full supported and Partially Support in the result. We did not show Not Support, we want to show how much each tool is close to MP7QF, and shows different levels of supporting to MPEG-7 Query format requirement. Where Query Management Tool part has not evaluated at all in all of online applications because we can not get the server side of these application. MP7QF make the sense that it focuses in the input query format much more with eighteen evaluations criteria, while there are only two evaluation criteria in the Output Query Format.

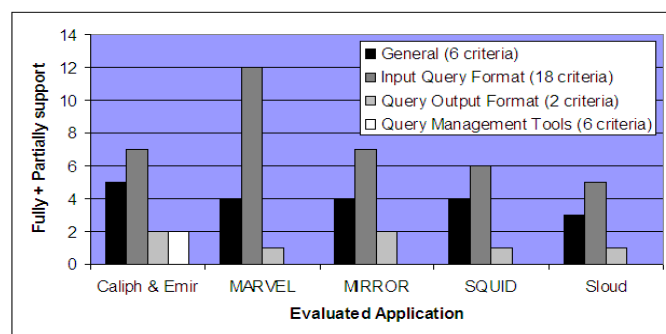


Figure 2. Evaluation Summary

A. The phase of MPEG-7 AV applications

After investigating the MPEG-7 industry and evaluating the different type of applications, we found that this area is still at the beginning phase, like we knew before. There is no mature application, and every application which we evaluated is still developing. For example, we got the information from the developer of C&E that they will publish their version soon which focuses on the query segment of image. The next version of MIRROR will include the semantic metadata retrieval. This information is all directly from their developers after we connected with them. Even a lot of applications only have the annotation part. So these applications are just on the beginning phase, and this industry has a long road to walk.

B. The utility of MPEG-7 AV applications

Honestly, there are no so many people actually using these applications which are now still in the research phase, not the commercial phase. MIRROR is just an experiment platform of colour similarity retrieval now. C&E is a relative integrity application. But when it deals with a huge amount of multimedia data, the server is easy to die or offer no response. Meanwhile, C&E is also a manual annotation application for image.

C. Mobility of MPEG-7 applications

In the mobile community, there is a need of accessing multimedia service any time, any where. There are expectations from researchers and industries expert that mobile phones are going to provide huge amount of customized multimedia contents [27]. In this project, investigating MPEG-7 industry and evaluating applications are not including mobile applications. Mobile devices have limited memory, limited battery power, small number of buttons, and small size. That leads to special needs for query format. An example in mobile content retrieval application, a tourist walking in the street of Stockholm who wants to go to the cinema, then he use his mobile device to connect to the Stockholm cinema database server, for example SF BIO. According to the user's preferences and location, a result comes back to the user showing the closest cinema location and the selection of movies. Then the user can then buy the tickets of the selected movie. On this example, the MMDDBMS should contain semantic data on the movie, retrieved information should respect limited mobile device environment.

MP7QF represents a general standard with undergo further change. Most of the requirements in MP7QF are powerful for mobile application; it offers a great feedback to mobile application developers.

D. Suggestion for the MPEG-7 query format requirements

One suggestion is about the output format requirements part. Considering the user's preference and the facility of history retrieval, we suggest that the standard should add another evaluate item in the output format. That is save the current retrieval result, because this function is very useful in the commercial field or comparison requirement. When people want to choose the best picture from the similar images, they can save the image chosen before and compare it with more pictures until they need. Such as the MIRROR in our evaluation, it allows the users to choose the any relevant pictures to modify the search each time until they find the desired image. It keeps the result of every search unless you cancel the result from the list. So we think this function which is useful and effective can be treated as output format requirements.

V. CONCLUSIONS

In this project, we classified and evaluated the MPEG-7 audiovisual applications based on MPEG-7 query format requirements, which means the purpose has been achieved. The applied methodology, that is, the quality experiment and quality survey according to different conditions was successful because of comprehension and completeness. We analysed the characteristic of the 5 MPEG-7 AV applications from a vertical view. It gives users a clear vision of the features, utility, phase of each evaluated applications, which will help users to choose the proper applications they need. Secondly, during the communication with the developers of these AV applications, we evaluated these applications from the view of a user, and gave them the some suggestions to find the defects and improve their future development.

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