Multimedia Storage System using Mpeg 7 Scheme based on Mobile Environment

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Abstract. Recent developments in wireless internet technology have gradually increased multimedia application in mobile devices. Specially, the application of grand capacity multimedia content has increased in the mobile environment. MPEG-7 can search multimedia data using various types. But in the restricted grand capacity of multimedia, MPEG-7 used to be limited primarily to desktop computer systems.In this paper, we propose a method for MPEG-7 data clustering that includes MPEG-7 data property. On the basis of the clustering result, we develop the embedded multimedia database management system based on the MPEG-7 scheme (EMDS:MPEG-7 Scheme Based Embedded Multimedia Database Management System) in mobile devices such as PDA.

***Key Words** : Multimedia; DBMS;Mpeg-7;Mobile;XML*

1. Introduction

With the development of wireless Internet and the wide spread use of various types of mobile terminals including PDA, diverse mobile applications are being introduced. However, there are not many applications that handle multimedia based on MPEG-7 in mobile terminals. This is because large capacity MPEG-7 data are not easy to handle effectively in mobile terminals. Thus, the present study proposed a MPEG-7 data clustering that reflects the characteristics of MPEG-7 data and, based on this method, developed MPEG-7 scheme based EMDS(embedded multimedia database management system)[1]. EMDS is composed of two layers. Rather than directly handling large capacity multimedia contents, the system manages only necessary data effectively with low-capacity hardware resources using metadata described in MPEG-7. The upper layer generates and manages MPEG-7 documents on multimedia effectively in a client/server environment. The upper layer is composed of MDGS (MPEG-7 Document Generation System) and MDMS (MPEG-7 Document Management System), and the lower layer is composed of MDSS (MPEG-7 Document Storage System). The upper layer generates MPEG-7 schema based MPEG-7 documents for all multimedia to be managed in MDGS. The generated MPEG-7 documents are integrated and managed as a client/server system by MDMS. The lower layer stores MPEG-7 documents. That is, MDSS clusters MPEG-7 documents based on MPEG-7 schema and stores them into a native embedded XML database[2].

2. RelatedWorks

XML databases can be divided into native XML databases and XML-enabled databases according to how they handle XML documents internally. Native XML databases objectify and store XML documents in the form of parsed. Accordingly, its search is fast because another parsing is not necessary in data extraction and only a desired part can be extracted regardless of the size of the XML documents. In comparison, XML-enabled databases manage XML documents by expanding existing database technologies based on relational or object-oriented data models. Thus, they abstract XML documents internally into the corresponding data model, and the documents can be handled using the operation of the data model. The present study utilized native XML database technology, which allows for fast searching[3].

Berkeley DB XML, which is a XML version of Berkeley DB, stores XML documents in a native form. Currently version 2.0.9 is being used, which is faster than version 1.2 thanks to indexing using XPath, stable thread base, data size, disk input/output, and effective management of data by the query processor for nodes selected by XPath.

The present study chose Berkeley DB XML, which is XML-based embedded DBMS, in client-server environments for the effective use of multimedia data in mobile environments considering the memory performance of small-size mobile devices such as PDA and Pocket PC, native XML storage system, the provision of JAVA library based on C and C++[4].

Previous researches on XML document clustering are largely divided into those on documents and those on schema. The former decides clustering policies using XML documents only but the latter analyzes XML schema for clustering. Document-based clustering uses an effective method of determining clustering policies with the input of XML documents without information on XML schema. This method handles an XML document, regarding it as a tree. Schema-based clustering is used when the schema or the frame of XML documents is known. In general, many well-defined applications have a schema for their XML documents. The schema predefines the structure of XML documents. Thus, using a schema, we can make more effective clustering policies. Improving this method, we propose a new clustering method for storing MPEG-7 documents in section 3

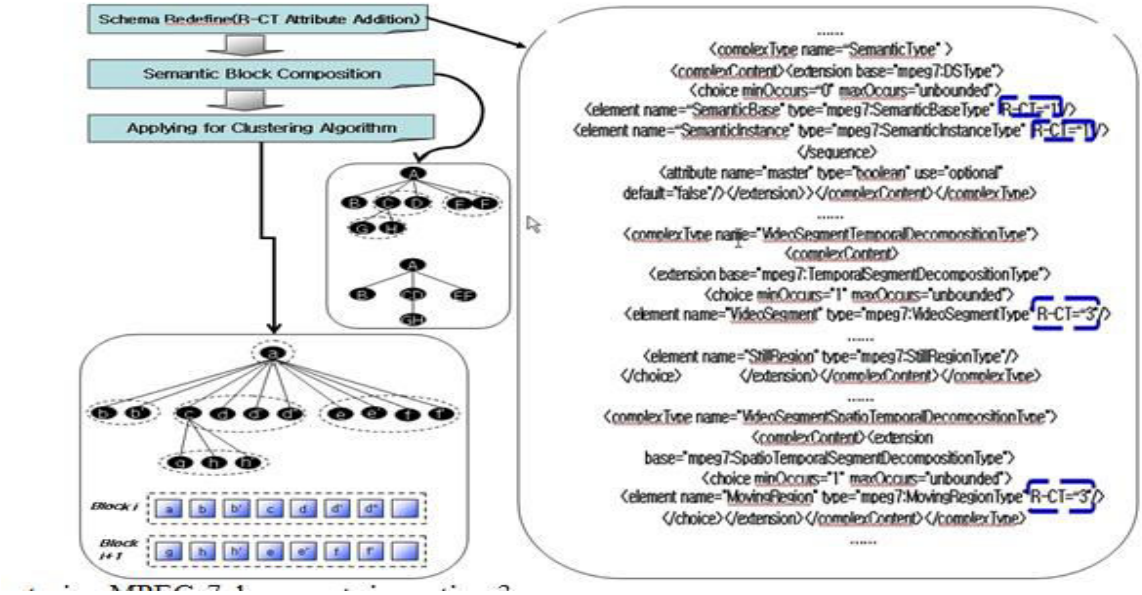

Figure 1.Mpeg-7Clustering

3. MPEG-7 Document Clustering

OrientX, which clusters XML documents by analyzing the schema of the documents, is a policy that regards an instance of semantic block as a logical record and stores nodes belonging to the same semantic block close to one another. However, when MPEG-7 documents are stored in the OrientX method, two problems arise. First, because MPEG-7 schema is very complicated, it is difficult to form semantic blocks simply with grammatical meanings. Second, the storage may ignore semantic relevance among MPEG-7 elements. Thus, this study proposes a three-stage MPEG-7 data clustering procedure that adds the R-CT attribute, which indicates organic semantic relevance among MPEG-7 elements and applies various semantic block generation rules[5].

The proposed clustering method is applied largely in three stages. In the first stage, the value of the R-CT attribute is added in order to express elements related to existing MPEG-7 schema (schema redefinition stage). In the second stage, semantic blocks are formed based on the redefined schema (semantic block formation stage). Lastly, in the third stage, clustering is conducted through the formed semantic blocks using a clustering algorithm (algorithm application stage). Fig. 1 shows the three-stage clustering application procedure.

4. Design of Embedded Multimedia Database Management System

Based on the MPEG-7 clustering devised in section III, we designed a MPEG-7 scheme based EMDS (embedded multimedia database management system) that can search and manage multimedia based on MPEG-7 scheme in mobile environment[6].

4.1 Structure of EMDS

Fig. 2 shows the system structure of the MPEG-7 scheme based EMDS.

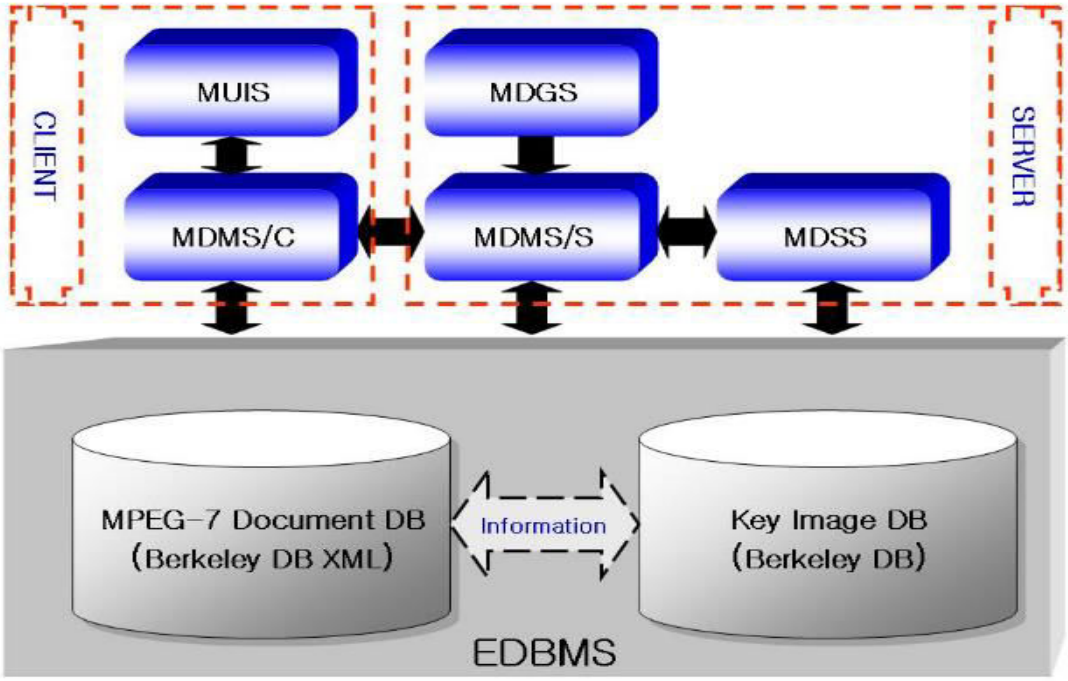

Figure2. System architecture of EMDS.

Considering the mobile user environment, we designed EMDS in a client/server structure. If a client requests various video searches using the multimedia search interface in MUIS (MPEG-7 User Interface Subsystem), MDMS (MPEG-7 Document Management Subsystem) on the client side is started and makes a query to the local database. The result of the query is returned through the interface, and if data is insufficient or there is no requested data in the local database, an additional search request is made to the server. For information requested by the client, the server executes the query to the global database and provides the results to the client's MDMS[7].

The results from the global database are stored in the local database and provided to the user through the multimedia search interface. With this search process, even if the client is disconnected from the server, it can use MPEG-7 documents and multimedia managed in the database of the client side. What is more, when communication between the client and the server is resumed, search results can be imported continuously from the global database. In this way, multimedia search can be executed more effectively in a mobile environment. For the continuous provision of video multimedia, the server side is composed largely of three subsystems: MDGS, MDMS and MDSS[8]. Of them, MDGS (MPEG-7 Document Generation Subsystem) converts multimedia data into MPEG-7 documents. Converted MPEG-7 documents are stored into the embedded XML database through MDMS (MPEG-7 Document Management Subsystem). Then, MPEG-7 documents converted through MDGS are sent to MDSS through MDMS. MDSS (MPEG-7 Document Storage Subsystem) processes documents blocked through MPEG-7 document clustering in the embedded XML database system. The following sections examine the design of these sub-systems[9].

4.2 Design of MPEG-7 user interface subsystem

MUIS (MPEG-7 User Interface Subsystem) is an interface for users to search and get various types of multimedia information and is composed of document generation interface, document management interface and video search interface[10].Fig. 3 shows the architecture of MUIS. MDGI (MPEG-7 Document Generation Interface) is an interface for extracting the characteristics of videos and entering metadata. It is composed of AI (Annotation Interface) for dividing a video into segments and entering annotation information and SI (Semantic Interface) for entering the semantic information of each segment. MDMI (MPEG-7 Document Management Interface) is composed of CMI (Classification Management Interface) for

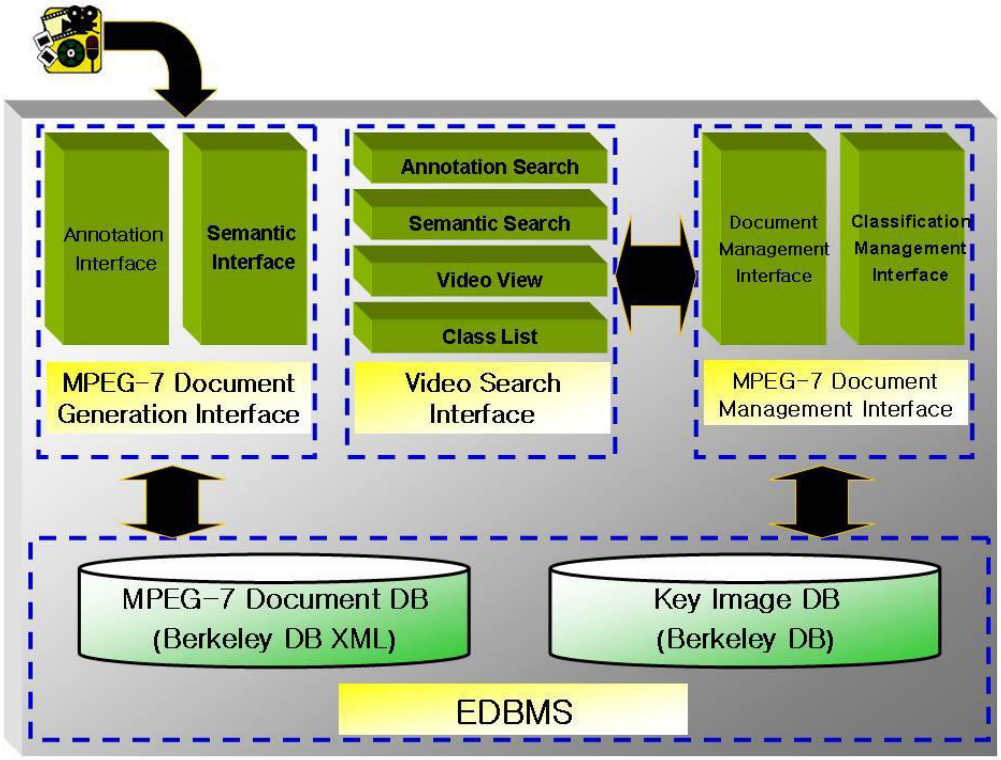

Figure3. Architecture of MUIS.

managing XML documents stored in the classification container of the data repository and DMI (Document Management Interface) for searching MPEG-7 documents and updating or deleting documents. VSI (Video Search Interface) in mobile terminals has largely four types: ASI (Annotation Search Interface) using video annotation information; SSI (Semantic Search Interface) using semantic information; VVI (Video View Interface); and CLI (Classification List Interface). ASI finds the desired frames by entering search keywords as well as search areas and purposes for characteristic extraction. SSI extracts identical semantic information from video materials and expresses the corresponding frame. VVI finds similar frames using RGB or various color values. CLI finds relevant frames based on classification criteria[11].

4.3 Design of MPEG-7 document generation subsystem

Fig. 4shows the architecture of MUIS. If a video is put into the server, MDGS (MPEG-7 Document Generation Subsystem) extracts the characteristics and metadata of the video and

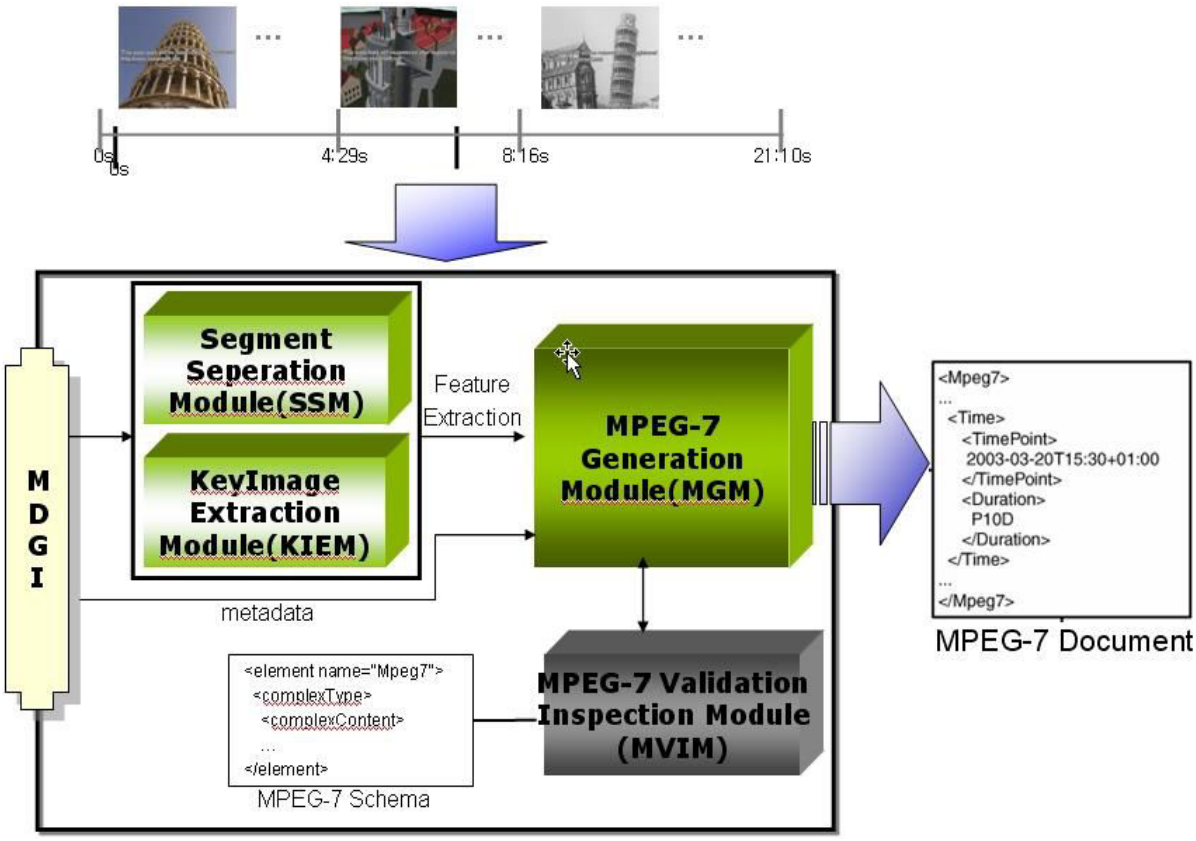

Figure 4. Architecture of MDGS.

generates a MPEG-7 document. If a new video is put into MDGS, it is divided into sequential segments manually using MUIS, and key images are

extracted from each segment. In addition, through MDGI (MPEG-7 Document Generation Interface), the user inputs metadata corresponding to each segment. Based on the information, MPEG-7 documents are generated in MGM (MPEG-7 Generation Module) by MPEG-7 descriptors and description schema. At that time, based on MPEG-7 schema, MVIM (MPEG-7 Validation Inspection Module) tests the validity of data type, data structure, etc[12]. For this, MDGS is composed of 4 modules: SSM (Segment Separation Module) for segment allocation to the whole video; KIEM (KeyImage Extraction Module) for extracting key images from divided segments; MGM (MPEG-7 Generation Module) for generating MPEG-7 documents; and MVIM (MPEG-7 Validation Inspection Module) for testing whether MPEG-7 documents follow the MPEG-7 standards. SSM extracts time information from the whole video based on DirectX 9.0 and when the user chooses a position for segment allocation while the video is being played, the position is extracted and the time information of separated segments are recorded. KIEM extracts key images from separated segments, generates image files, and records information on the positions from which the key images have been extracted. MGM gathers video information extracted by each module and metadata entered by the user,

and generates MPEG-7 documents using MPEG-7 descriptors and description scheme. At that time, the MPEG-7 documents are stored temporarily using the list class of Visual C++. MVIM checks if generated MPEG-7 documents follow the MPEG-7 standards. It tests the validity of the structure of generated MPEG-7 documents and the data type of elements[13].

4.4 Design of MPEG-7 based document management subsystem

MDMS (MDMS: MPEG-7 Based Document Management Subsystem) stores and manages MPEG-7 documents generated by MDGS in the data repository in the lower layer through the MPEG-7 document management system of the server. The client side searches videos through communication with the server using an interface for searching various videos. Search results, namely, videos and MPEG-7 documents are stored and managed in the data repository in the lower layer through client version MDMS (MDMS/C). Fig. 5 shows the structure of MDMS[14].

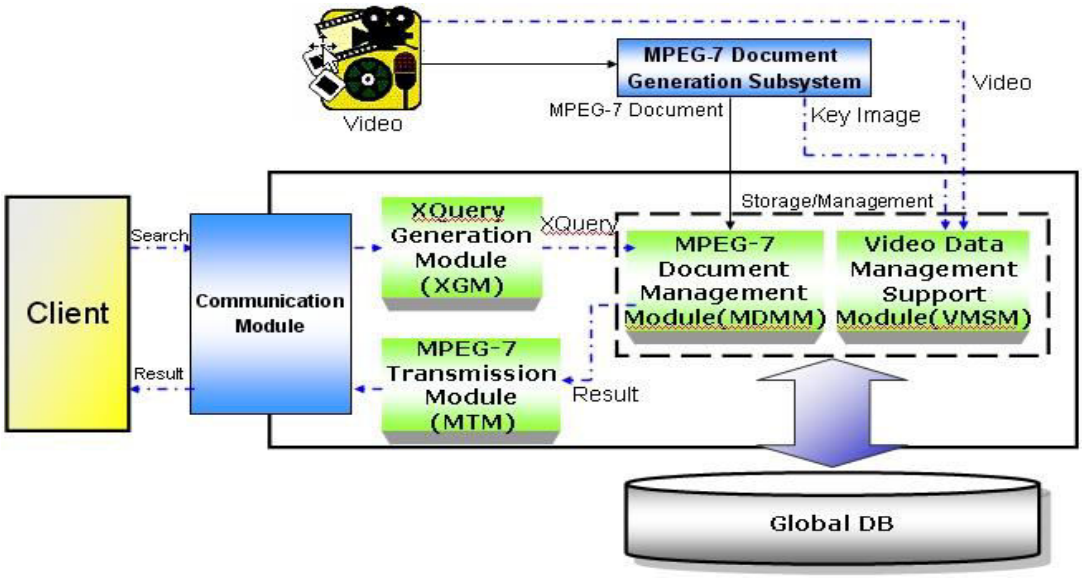

Figure5. Architecture of MDMS.

MDMS is composed of 4 modules: XGM (XQuery Generation Module) for searching MPEG-7 documents; MDMM (MPEG-7 Document Management Module) for managing MPEG-7 documents; VMSM (Video Data Management Support Module) for managing key image mapping information, and MTM (MTM: MPEG-7 Transmission Module) for converting MPEG-7 documents into binary data and transmitting the data[15]. When an MPEG-7 document comes from MDGS, it is stored into the global database in the lower layer through MDMM and video data and extracted key images are stored and managed in the global database through VMSM. In addition, if a search request arrives from the client, XQuery is generated through XGM based on search keywords, the global database is searched, and the corresponding data are returned to the client. When search results are sent to the client, MPEG-7 documents are converted into a binary form by MTM and transmitted. The client side also has MDMS for storing and managing searched videos but the subsystem in the client

side has only essential functions, excluding transaction, parallel processing and other server functions, in consideration of the environment of the mobile terminal[16].

5. Conclusions and Future Research

The present study proposed a new data clustering method reflecting the characteristics of MPEG-7 documents and, based on the method, developed EMDS (MPEG-7 Scheme Based Embedded Multimedia Database Management System) for mobile terminals. MPEG-7 clustering improves query processing performance by supporting clustering based on MPEG-7 schema and is applicable to various types of MPEG-7 document storage systems by generating semantic blocks fit for MPEG-7 applications.

Different from previous systems, the EMDS we developed can search and manage multimedia effectively in mobile terminals, demonstrating a high query processing rate by supporting data clustering that reflects the characteristics of MPEG-7 documents and a high level of efficiency in the management of MPEG-7 documents in mobile terminals with limited resources by using an embedded XML database system. Furthermore, as it provides an integrated environment for the generation and management of MPEG-7 documents, it can search a large volume of MPEG-7 documents consistently, and search MPEG-7 based multimedia in a mobile environment without the limitation of time and place.

The current EMDS supports semantic search through establishing a fixed semantic relation of R-CT. Thus, in order to support a perfect semantic search, we need additional development for establishing various types of relationships. In addition, the proposed clustering algorithm should be adapted to the semantic search for higher efficiency.

References

1. Bae. H. and Kim, M., 2007. Process based Storing and Reconstructing of XML Form Documents. Computers in Industry. 58:1, January, 87-94.
2. Bar-Yossef, Z.,Fontoura, M. and Josifovski, V., 2007. On the Memory Requirements of XPath Evaluation over XML Streams. Journal of Computer and System Sciences. 73:3, May, 391-441.
3. Brian, D., 2006. The Definitive guide to Berkeley DB XML, APRESS.
4. Chaudhri, A Rashid. and R Zicari, 2004. Native XML and XML-Enabled database systems. ACM SIGMOD. 55, 90-99.
5. Chaudhuri, S.and Gravano, L., 1996. Optimizing Queries over Multimedia Repositories. ACM SIGMOD. September, 91-102.
6. Fiebig, T. S Helmer, CC Kanne, and G Moerkotte., 2002. Anatomy of a Native XML Base Management System. VLDB. 11:4, 292-314.
7. Fjellheim, T., Milliner, S., Dumas, M. and Vayssière, J., 2007. A Process-based Methodology for Designing Event-based Mobile Composite Applications. Data & Knowledge Engineering. 61:1, April, 6-22.

8. Fonseca, P.M. and Pereira, F., 2004. Automatic Video Summarization based on MPEG-7 Descriptions. Signal Processing: Image Communication. 19:8, September, 685-699.
9. Frank, S., Tseng, C.and Hwung, W.J., 2002. An Automatic Load/Extract Scheme for XML Documents through Object-relational Repositories. Journal of Systems and Software. 64:3, December, 207-218.
10. Guillaume, A. and Murtagh, F., 2000. Clustering of XML Document. Computer Physics Communications. 127:2, 215-227.
11. Haustein, M.and Härder, T., 2006. An Efficient Infrastructure for Native Transactional XML Processing. Data & Knowledge Engineering. In Press, Corrected Proof, Available online 21 July.
12. Kapela, R.and Rybarczyk, A., 2007. Real-time Shape Description System Based on MPEG-7 Descriptors. Journal of Systems Architecture, In Press, Accepted Manuscript, Available online, January.
13. Kosch, H., 2002. MPEG-7 and Multimedia Database Systems. ACM SIGMOD. 31:2,61-64.
14. Lee, K.L. and Chen, L.H., 2005. An Efficient Computation Method for the Texture Browsing Descriptor of MPEG-7. Image and Vision Computing. 23:5, May, 479-489.
15. Lee, M., Yang, L., Hsu, W. and Yang, X., 2001. XClust: Clustering XML Schemas for Effective Integration. ICAR-CNR. 19:1, March, 151-158.
16. Leonardi, E. and Bhowmick, S.S., 2006. A Scalable Change Detection Technique for Ordered XML Documents using Relational Databases. Data & Knowledge Engineering. 59:2, November, 476-507.