1. INTRODUCTION

Multimedia Database Systems (MMDBMS) organize and store multimedia data for content retrieval. The relying multimedia data models, e.g., [9], represent abstractions of media objects for querying, indexing, and so on. However, most currently available implementations reveal shortcomings. Either they are limited by one kind of multimedia data supported or by the capacity of their semantic modeling. Despite the upcoming MPEG-7 standard for representing low-level and high-level features of multimedia and respective annotation and use tools (see http://www.mpeg-industry.com), we are not aware of any MMDBMS product which integrates this standard for the purpose of a more meaningful indexing and querying.

In this context, our paper presents a Multimedia Data Cartridge (MDC) for demonstration at ACM Multimedia 2002 that implements an object-relational data model for the core part of the MPEG-7 [6, 5] standard. It is an open and extensible system realized with the Oracle Data Cartridge technology [7]. Oracle offers with that technology a mechanism for extending the capabilities of an Oracle database (e.g., type system, query processing and indexing) for the users needs. Besides the more effective modelling of multimedia content, efficient retrieval was considered. Efficient query processing is guaranteed through new database indexing mechanisms. Innately, most database systems provide only a limited number of integrated access methods such as B-trees. Available multimedia database extension packages (e.g., DataBlades of Informix) rarely handle indexing of d-dimensional data (e.g., feature vectors [3, 8] with \( d \geq 2 \)) or advanced similarity search functionalities (e.g., k-NN search). These circumstances limit the use of database systems in multimedia. For overcoming this drawback, we introduce an Multimedia Indexing Framework (MIF) relying on the GiST framework [4]. Finally, in order to use the MMDBMS we provide query and presentation interfaces which automatically adapt to their usage environment.

2. DESCRIPTION OF THE SYSTEM

The Multimedia Data Cartridge (MDC) currently consists of two parts (see figure 1). At first, the Multimedia Data Model represents the metadata describing the multimedia content relying on MPEG-7 descriptions. For this purpose, the MPEG-7 schema is mapped, with the help of Oracle’s extensible type system, to a database schema, i.e., to respective object types and tables (see Appendix 1). The mapping is demonstrated on the MPEG-7 StillRegion-Type and VideoSegment which is a delegate for images and videos (e.g., StillRegion describes complete images or parts of them). Some of that attributes are declared as separate object types, or are defined as basic types and others are specific SYS.XMLType. The decision which type to use depends on the importance for the querying process. For instance, the attribute with type TextAnnotationType was chosen to be detailed further, because it is of importance for free-text search. A further important type is Scalable-ColorType which is used for storing feature vectors of color histograms extracted from images described by the StillRegionType.

At second, the Multimedia Indexing Framework (MIF) provides an extensible environment for multimedia retrieval. The framework is divided into three modules (see figure 1).

- The GistService is realized in the external address space and runs as an own process in the Operating System environment. It manages all available access methods and offers currently support for the Generalized Search Trees (GiST [4]). The GistService may also support further access methods not relying on balanced trees (e.g., LPC-files [1]) to support efficient NN-search in high dimensional vector spaces or indexing text annotations with the help of the DependencyStructure DS [6]). The two main components are the GistCommunicator and the GistHolder. The GistCommunicator is a COM-Object and is used for inter-process communication between the database (the GistWrapper shared library) and the implemented access methods. The GistHolder manages all currently running index trees and the accesses to them. Each index tree is identified through a global and unique ID.

- The GistWrapper is a shared library and is used by the database to connect to the GistService module. The GistWrapper has two tasks, namely the accessibility of the GistService through database procedures and the transfor-
The Multimedia Index Type is the necessary part in the Oracle address space. The multimedia index type consists of several indextypes, that represents all available access methods and their corresponding operators. Every indextype need an appropriate implementation (object). The object delegates all necessary index methods (e.g., ODCIIndexInsert, ODCIIndexCreate, ...) to their corresponding implementations. In MDC, most methods are forwarded to the GistService.

Experimental results (see [2]) have shown effectiveness and efficiency. Effectivity is guaranteed through the extension of the index services to multimedia specific operations (e.g., NN-search). Efficiency has been measured by various experiments. Our framework outperforms the Oracle Text Index (NN-search). Efficiency has been measured by various experiments. Our framework outperforms the Oracle Text Index (NN-search).

The use of RDF enables a standard way of exchanging information about the client’s capabilities. A CC/PP standard implementation, Dice, was extended and integrated into the client/server environment to adapt the query interfaces to the respective environment requirements.

3. DEMONSTRATION PLAN

The intended demonstration at ACM Multimedia 2002 will consists of at least three parts. First we are demonstrating the insertion and deletion functionality of our MMDDBMS. We show this for the VideoPublisher Plugin.

Second, we show the adaptive query and presentation interfaces and demonstrate their behaviour for different terminal capabilities. Different query classes are provided, ranging from simple free-text, semantically meaningful querying, (e.g., give me all goals from the team of Germany in this year’s world football cup), to combined low- and high level querying (restrict the former query to matches where the German wear their traditional white/black dresses). Efficiency is the next point for demonstration. We first show the available retrieval methods (range queries, NN-search) and presents their output on a sample databases, e.g., search a given image in a 90min movie. Second, we demonstrate the data distribution and the index balance with the amdb tool (see Appendix 3), taken from the University of California, Berkeley. It will be used for creating modified and more efficient indexing methods, optimized for MPEG-7 data.

4. REFERENCES


---

Figure 2: Distributed Multimedia Environment

Indexing, Query and Presentation Interfaces

Figure 2 shows how the MDC is embedded into the distributed system’s context. Three interfaces, as marked in figure 2 are relevant for this demonstration.

1. We provide plugins for various tools which handle and produce MPEG-7 data, e.g., for Video Publisher and Movie Tool. The MP7 documents to be included into the MMDBMS are analyzed and then split up into objects and tables according to our data model.

2. This stored information can then be queried and presented with the help of an adaptive query and presentation interface which is connected through a web server, aware of usage environment descriptions from the clients, to the MMDBMS. It is described below.

3. Finally, we provide an interface which offers a connection to video servers where we are synchronizing the generated MP7 information (describing the query hits) with MP4 streams for enabling stream adaptation during network transfer.

Let us detail the second interface. In order to serve multiple client front-ends (e.g., hand-held, PC or Palm user) the database queries are submitted through an Adaptive Query Interface. Adaptation means the dynamic adjustment of the interface to the client’s terminal capabilities (e.g., Hardware, Software). An screenshot of the Adaptive Query Interface is shown in Appendix 2. Besides the query, also the results (meta-data), and the respective streams are shown and their presentation windows are adapted. The terminal capabilities are described with the help of CC/PP which is a standardized framework developed by W3C, based on the RDF (Resource Description Format).

---

Appendix 1: DB-Schema derived from MPEG-7 MDS
Welcome to the adaptive Query Interface!

Welcome to the demonstration site (Device Independent Content Engine). This project makes use of COFP (Composite Capabilities Preference Profiles) profiles to only give the user content that they want and can use.

Semantic Query Interface for a client

Appendix 2

Semantic Query Interface for a stronger client

Input form for the Device Info
Appendix 3

**Node View**
Displays bounding predicates (BPs) and items within nodes.

Highlights BPs on current traversal path.

**Split Visualization**
Shows how BPs or data items are divided with PickSplit( )

**Node Contents**
Provides textual description of node