Chapter VI

Distributed Temporal Video DBMS Using Vertical Class Partitioning Technique[1]

Chi-wai Fung
HK Institute of Vocational Education, Hong Kong

Rynson Lau and Qing Li
City University of Hong Kong, Hong Kong

Hong Va Leong
The Hong Kong Polytechnic University, Hong Kong

Antonio Si[2]
Oracle Corporation, USA

In this chapter, we describe our work on developing a distributed video DBMS (database management system). The video DBMS provides a temporal modeling framework for describing video data and it supports data distribution by applying vertical class partitioning techniques. Building on top of our previous work on Four-Dimensional Information Space (4DIS) - an object-oriented temporal modeling framework, we apply class partitioning techniques onto a distributed 4DIS video database system as a means for efficient query execution. A detailed cost model for query execution through vertical class partitioning is developed. The effectiveness of our class partitioning approach, in the context of the distributed 4DIS video database system, is demonstrated through the use of a running example.

INTRODUCTION

Performance is a key factor for the success of distributed multimedia database systems, especially when supporting semantically rich applications such as Video Database Management (Chan and Li, 1999; Chan and Li, 2000; Si, Leong, Lau, and Li, 2000a), Digital Libraries (Chim, Lau, Leong, and Si, 1998) and Geographical Information Systems (Choy, Kwan, and Leong, 2000). For these applications, complex multimedia object query execution has a major impact on the cost of query processing (Karlapalem and Li, 1995; Karlapalem and Li, 2000). One of the ways to improve the performance of complex multimedia object query execution is to use a class partitioning technique, in particular, vertical class partitioning. This is because without any particular storage technique, complex multimedia objects are stored sequentially (clustered by the class extension) and query executions are processed by pointer traversal and sequential scanning of the database. But the cost of complex multimedia object query execution using pointer traversal and sequential scanning is very high, especially when:

- the multimedia objects are large, which is the usual case;
- component multimedia objects to be retrieved are deep inside the class composition hierarchy; or
- we are not interested in the content of the multimedia objects, but rather the relationship among the complex multimedia objects/component objects.

Distributed multimedia database systems are becoming popular. In these systems, it is critical not only to have efficient implementation but also a good design of the database system. Our design is motivated by the requirements that a good multimedia video database system should possess, namely, flexibility and performance. In particular, the system should allow system designers to model video objects easily. We envision the need to define temporal relationships among video objects readily. To improve performance, data retrieval cost should be reduced wherever possible. This spawns off a number of needs. The utilization of a plurality of hardware, with proper allocation mechanisms for video objects to the hardware for parallel processing and retrieval is very important. Furthermore, a good filtering mechanism to trim down the amount of objects to be accessed and retrieved for a particular query through proper object allocation and query processing is of equal importance. As such, the following issues are considered to be relevant and very essential for us to address:

1) Temporal semantics constitute an important aspect of modeling video data and meta data. A graceful data model that facilitates uniform modeling of temporal relationships among videos is therefore fundamental and very much needed.

2) Vertical class partitioning is a design technique for reducing the number of disk accesses needed for executing a query by minimizing the number of irrelevant instance variables/component objects accessed. This is accomplished by grouping the frequently accessed instance variables/component objects as vertical class fragments. The complexity of object-oriented/object-relational distributed multimedia database due to subclass hierarchy (IS-A hierarchy) and class composition hierarchy (IS-PART-OF hierarchy) complicates the definition and representation of vertical partitioning of the classes, and makes the problem of vertical class partitioning very challenging.

3) An analytical cost model for query execution in distributed video databases is essential for query optimisation and for comparison between different query execution plans.

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