Script for Audio-Visual Discussion of System Architecture

The [query interface] demonstration described a query interface that supports search and discovery in the VDBMS video database system. This client software connects to the VDBMS database server that resides on a SUN Enterprise 450 with 4 UltraSparc II processors located at Purdue University. The VDBMS system is built on top of an open source system consisting of Shore, the object storage manager developed at the University of Wisconsin, and PREDATOR, the object relational database manager from Cornell University. The VDBMS research group has developed the extension and adaptations needed to support full database functionality for the "video" as a fundamental database object. Key extensions include high-dimensional indexing, a rank join operator for multi-feature queries, real-time video streaming, search-based buffer management policies, and support for tertiary storage.

The diagram illustrates our layered system architecture, consisting of the object storage system layer at the bottom, the object relational database management layer in the middle, and the user interface layer at the top. The original components from the Shore/Predator system are shown in gray, and the VDBMS adaptations of the original system are green. In the bottom layer, the original Index, Buffer and Storage Managers were modified extensively to provide video-enhanced capabilities. The VDBMS Index Manager extends the indexing capability of Shore by incorporating the Generalized Search Tree implementation of the SR-tree as our high-dimensional index. A "vector" ADT was created for the high-dimensional visual feature fields, and an instance of the SR-tree is used for these fields as the access path in feature matching queries. Extended buffer management handles multiple page requests with segment allocation for the large streaming requests from the stream manager. An interface between the buffer manager and the stream manager is used to exchange information that guides buffer caching for stream requests. Methods for handling extended storage hierarchies support real-time access to buffer, disk, and tertiary storage. A tertiary storage server manages access to tertiary resident data, making it directly accessible to the VDBMS system.

In the object relational database management level, a Stream Manager was added and the Query Manager was modified extensively to handle the new high-dimensional index schemes and to support complex multi-feature rank-join queries and video query operators. A new real-time stream manager component admits, schedules, monitors and serves concurrent video stream requests periodically. The stream manager has well-defined interfaces with other database components, such as the query engine, the buffer manager, and the E-ADT interface. The stream manager uses the inherent connection between query search results and streaming requests for a search-based policy that reduces initial latency and disk I/O during the streaming process. Pre-fetching and caching are based on both current and expected video streams. The top-ranked search results from the query manager are used to predict future video streaming requests; this information guides the database buffer replacement policy. An incremental, pipelined rank-join operator was developed and added to the query execution plan to support optimal aggregate ranking for image similarity searches based on multiple features. New query video operators for stream query processing on multiple infinite input data streams are currently under development.

In the top layer is the client side software that supports application layer processing. The query interface supports video content-based queries, retrieval and presentation. Content-based searching is supported by a video toolbox that applies image and semantic processing to partition videos into shots associated with visual and semantic descriptors that identify and index video content for searching. Image processing techniques include shot detection, key frame extraction, low-level feature extraction, camera motion classification, and spatial and temporal segmentation. The video, its features and its indices are stored in the VDBMS database. MPEG7 standards for multimedia content descriptors are an integral part of VDBMS feature representation, and VDBMS processing extracts nearly all low-level features defined by MPEG7 as standard, including color histogram in both HSV and YUV formats, texture tamura, texture edges, color moment and layout, motion histograms, edge histograms, dominant and scalable color, and homogeneous texture. Efforts are underway to create an XML wrapper to import user-supplied MPEG7 documents generated using multimedia description schemes for high level and low-level feature information. The document features are parsed and mapped to the VDBMS feature schema.

The VDBMS system has been tested against more than 800 hours of medical videos obtained from the Indiana University School of Medicine