Outline

- **Introduction**

- **Storage Architecture**

- **VCR-like Operation**

- **Conclusion**

Introduction

- **Goal**
  - a MOD server that stores movies in compressed digital form and provides support for different portions of compressed movie data to be accessed and transmitted concurrently

- **Issue**
  - low cost
    - » minimize the buffering requirement
  - continuous retrieval of movies
    - » each portion would be transferred to the buffer just prior to its playback time
  - support for VCR-like functions
    - » minimize the response time for switching back to normal display mode from pause, fast-forward, and rewind modes
  - service multiple viewers concurrently

Storage Architecture

- **Overall system architecture**
  - **movie library : a juke-box of tapes**
  - **server : a *storage hierarchy***
    - » **disks : store the popular movies**
    - » **a small amount of RAM buffers : store portions of the movies**
  - **decoder**
    - » **consume the compressed movie data from a local buffer and output frames to a display**
  - **see figure 1.**

Storage Architecture

- **Storage allocation**
  - **requirements**
    - » **maximize the number of concurrent phases**
      - • **upper bound :**
    - » **minimize the amount of movie data to be buffered in RAM**
  - *contiguous* **allocation**
    - » **formula :**
    - » **the buffer size per phase increases both with latency time of the disk and the number of concurrent phases**
  - *phase-constrained* **allocation**
    - » **store** *movie matrix* **on disk sequentially in column-major form**
    - » **formula :**
    - » **eliminate seeks to random locations in disk, but only concurrent phases with fixed** *phase differences* **are supported**
    - » **see figure 2. and figure 3.**

Storage Architecture

Storage Architecture

- **Buffering**
  - implemented as a *circular buffer*
  - the size of each buffer is 2d
    - » one half is used to read in a portion of the movie from disk
    - » the other half is a portion of the movie transmitted to display

- **Repositioning**
  - no data can be transferred if the head is being repositioned
  - maintain another disk with exactly duplicate data
  - divide the *movie matrix* into two submatrices on two disks
    - » if *smallest phase difference* is at least twice repositioning time
  - store the last m portion of column-major form representation of the movie in RAM
    - » if

VCR-like Operation

- **Video compression algorithm**
  - **MPEG encoder**
    - » **Intraframe (I), Predicted (P), Bidirectional (B) frames**
    - » **Repeat (R) frame**
  - **MPEG decoder**
    - » **a process at viewer site continuously monitors decoder buffer**

- **Control operation**
  - **begin : *current movie buffer***
  - **pause : transmit the R-frames**
  - **fast-forward, rewind**
    - » **skip some bits, but transmit *independent sequences* of frames**
  - **resume**
    - » **eliminate the delay in resuming normal display after pause**

Conclusion

- **Contribution**
  - **a low-cost storage architecture for a MOD server**
  - **a storage allocation scheme that enables multiple different portions of a movie to be concurrently retrieved**
  - **schemes for implementing VCR-like operations**

- **Related work**
  - **satisfy multiple concurrent requests for the retrieval of multimedia objects on disks**
    - » **similar to the *contiguous* allocation scheme**
    - » **unsuitable for handling large number of requests concurrently**
  - **use parallelism to support the display of high resolution of video data that have high bandwidth requirements**
    - » **a multimedia object is declustered across several disk drives**
    - » **the aggregate bandwidth of multiple disks can be utilized**