Extracting Information from Video

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Background

- No way to get information out of videos currently
- Research is being done on algorithms for scene change detection
- Parallel algorithms written to process videos
Frames in Videos

- Intra-coded (I) frames
- Predicative-coded (P) frames
- Bidirectionally-coded (B) frames
- DC-coded (D) frames
Scene Changes

- Gradual scene changes
- Abrupt scene changes
Detection Algorithms

- Nagasaka and Tanaka Algorithm
  - Compares difference between windows in frames
  - 90% success rate with abrupt changes

- Other Abrupt Detection Algorithms
  - Otsuji – changes in brightness within pixels
  - Akutusu – velocity of images in frames
  - Hsu – Gaussian and mean curve of various surfaces
Detection Algorithms

- Gradual scene change algorithms
  - Tonomura
    - Detects both types of changes
    - Uses frames before and after current frame
  - Zhang
    - Template matching
    - Likelihood ratio between two images
    - Histogram comparison
    - $x^2$ squared histogram comparison
Detection Algorithms

- Gradual scene changes
  - Shahraray
    - Motion-controlled temporal filtering
    - More consistent with human judgement
  - Zabih
    - Edge-changing fraction
    - Deals with fades, dissolves, and wipes
Scene Changes in Compressed Video

- MPEG Algorithm
  - Yeo and Liu
  - Template matching and color histogram
  - Gradual and abrupt

- JPEG Algorithm
  - Arman
  - DC coefficients

- Problems with Compressed Video
Top Down Approach

- Use models of a system to create algorithm
- Hampapur’s production model
  - 88% success rate
- Aigrain and Joly’s motion difference model
  - 94-100% for abrupt
  - 80% for gradual
Determining Algorithm’s Success

- No set criteria
- Authors propose criteria including:
  - CPU time
  - Success in finding changes
  - Avoiding false detections
  - Types of scene changes
  - Applications algorithm runs on
  - Types of video algorithm can run on
Two Approaches

- Approach One
  - DC frames Y, U, and V components
    - Drastic lighting differences in consecutive frames
  - Motion Vectors
    - Used to detect Pans and Zooms
Two Approaches

- Approach Two
  - DC image strips
    - Horizontal, Vertical and Diagonal strips are extracted from each frame
    - The strips are pieced together to form three 2-D images
    - Both gradual and abrupt scene changes are computed based on the shape of the boundaries between images
    - Motion not detected
Parallel Processing of Videos

- Authors took two approaches in designing algorithms
- Tested each approach for three levels:
  - GOP – Group of Pictures
  - Frame
  - Slice
Evaluation of Algorithms

- First determined analytically
- Second did actual tests
Experimental Results

- Similar to our homework testing
- Compiled the algorithms and tested with various test cases
- Results showed that algorithms ran best at the GOP level
- Frame and slice were similar
Approach 1 GOP Level

- Done on task queue size of 32 and 48
- Similar results
  - Maximum number of processors is 32
  - Entering item into queue takes more time than processing frame
Speedup graph

(a)

(b)
Approach 2 GOP Level

- Similar to Approach 1 GOP level
- Synchronization overhead increases as the number of processes increase
- Again because of time to process frame versus time to insert work into the queue
Speedup and synchronization overhead
Approach 1 Frame Level

- Tested on 32 frames and 48 frames
- Results were suboptimal due to overhead in parallelization
- Speedup stops after 12 processes
Speedup

(a) Speedup Curve: Frame Approach 1
Task Corpus Size = 32

(b) Speedup Curve: Frame Approach 1
Task Corpus Size = 48
Approach 2 Frame Level

- Similar to Approach 1, no significant speedup after 12 processes
- Again due to synchronization overhead
Speedup and overhead
Approach 1 Slice Level

- 4 frame resolutions
  - 32
  - 64
  - 96
  - 128

- 2 task queue sizes
  - 32
  - 48
Approach 1 Slice Level

- Performs worse than GOP, better than frame
- Has synchronization overhead
Speedup
Approach 2 Slice Level

- Performance declines after 12 processes
- Similar to Approach 1 for Slice Level
Speedup and overhead
Future Work

- Implementing criteria to judge algorithms
- Algorithms for different formats
- Commercial products like TiVo
Questions?