Compression effects on color and texture based multimedia indexing and retrieval

IEEE trans Image Processing, ICIP 2003 proceedings

D-E. Guldogan, O. Guldogan, S. Kiranyaz, K. Caglar and M. Gabbou

Yuanyuan Yue

Content

- Background and Motivation
- Content-Based Image Retrieval
- MUVIS-Multimedia Browsing, Indexing and Retrieval System
- Experiments and Results
- Conclusion and Interpretation

Background and Motivation

- Lager size of digital visual information
- Digital compression and multimedia indexing and retrieval
- Lossy compression cause crucial information loss

  - degrade the results of multimedia retrieval
- Data loss causes a filtering effect on the visual attributes

  - enhance the retrieval performance

How is the real effect of data compression on image and video retrieval?

Content-Based Image Retrieval

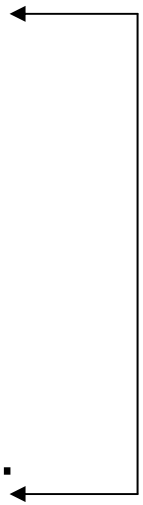
- Images have rich content.
- This content can be extracted as various content features:
  - Mean color , Color Histogram etc…
- Take the responsibility of forming the query away from the user.
- Each image will now be described by its own features.

CBIR – A sample search query

- User wants to search for, say, many rose images
  - He submits an existing rose picture as query.
  - He submits his own sketch of rose as query.
- The system will extract image features for this query.
- It will compare these features with that of other images in a database.
- Relevant results will be displayed to the user.

Feature Extraction

- What are image features?
- Primitive features
  - Mean color (RGB)
  - Color Histogram
- Semantic features
  - Color Layout, texture etc…
- Domain specific features
  - Face recognition, fingerprint matching etc…

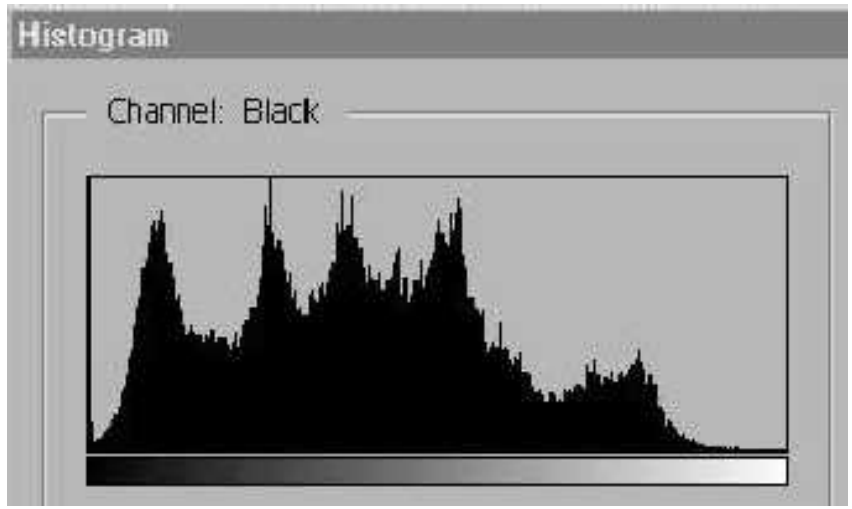


General features

Histogram

- Frequency count of each individual color
- Most commonly used color feature representation

Image



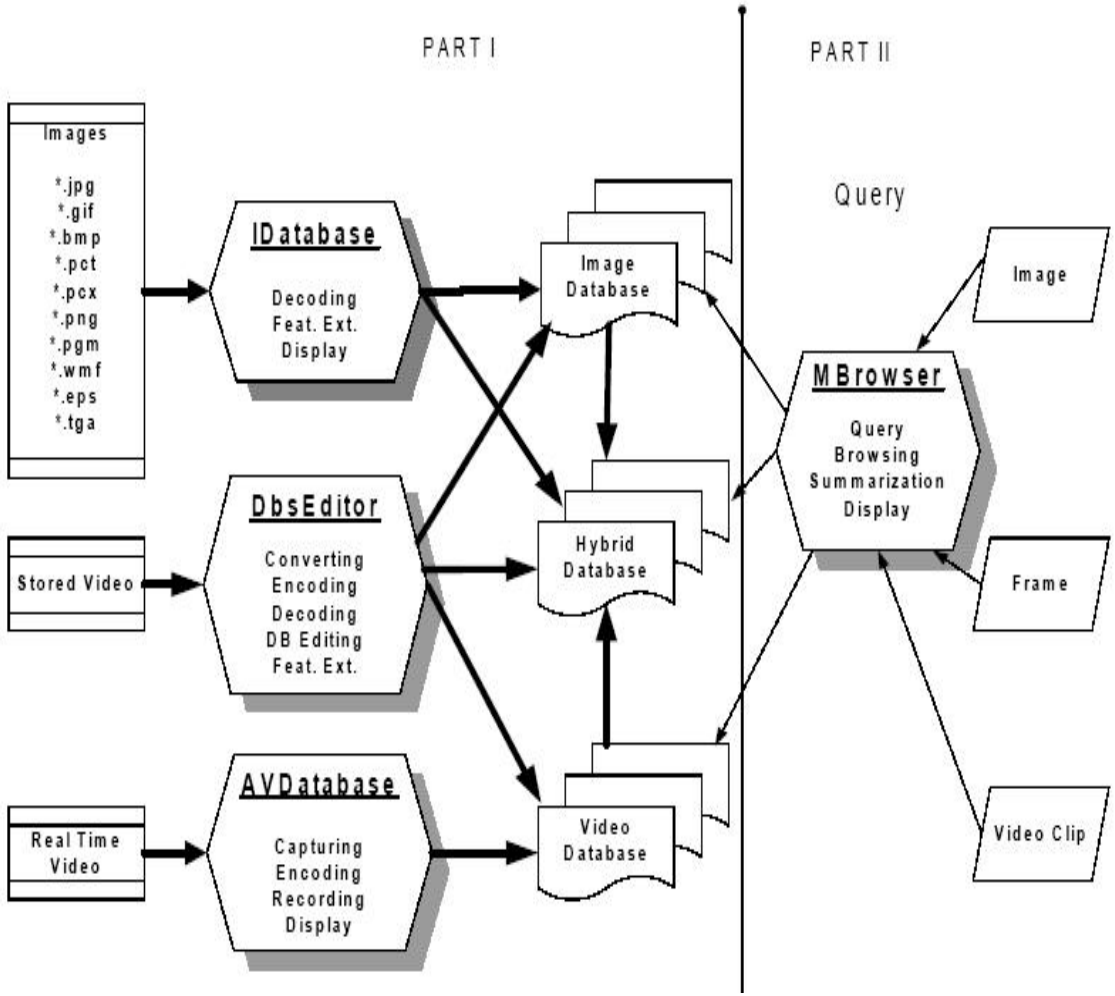
Corresponding histogram

Texture

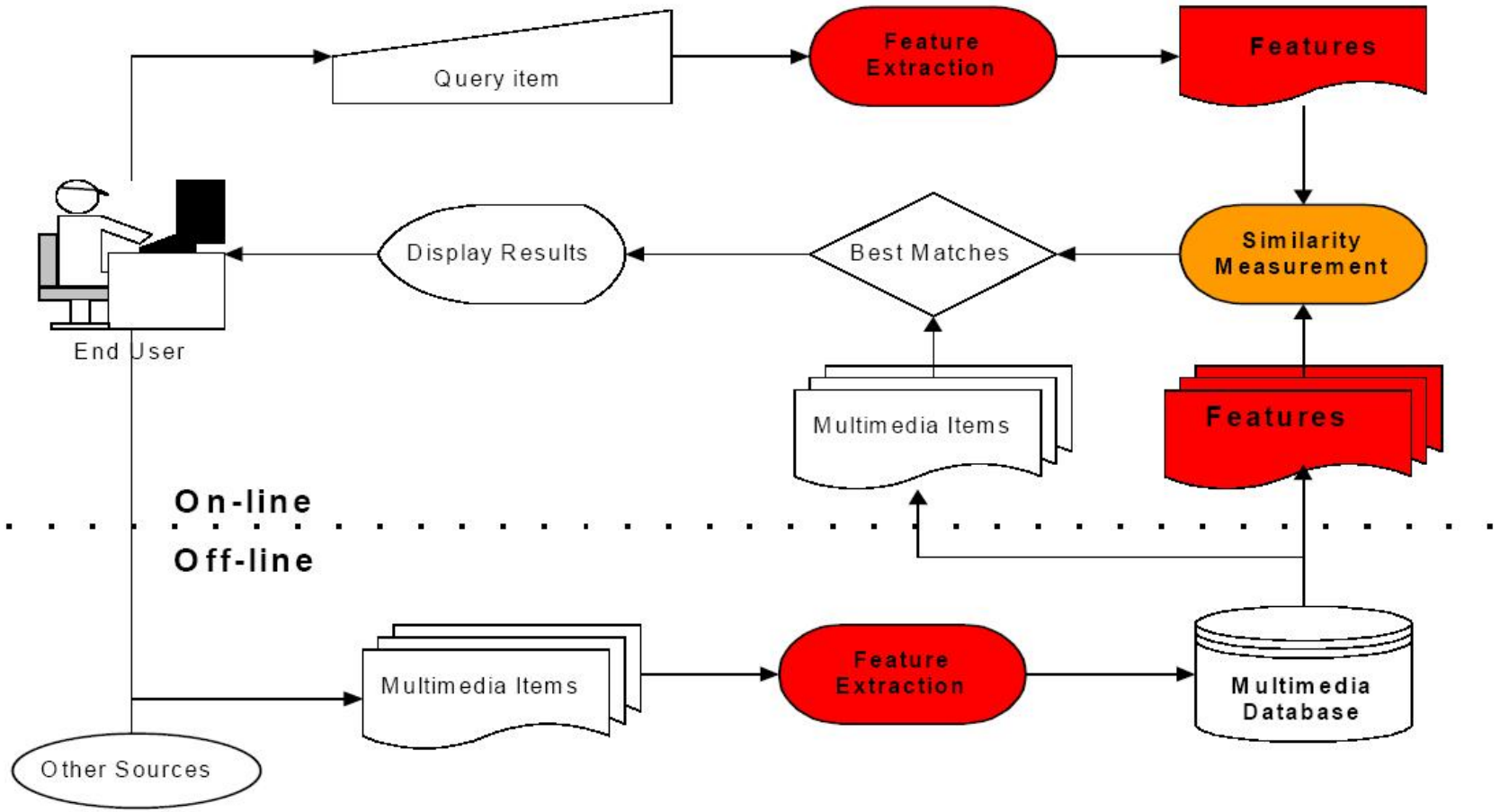
- Texture – innate property of all surfaces
  - Clouds, trees, bricks, hair etc…
- Refers to visual patterns of homogeneity
- Does not result from presence of single color
- Most accepted classification of textures based on psychology studies –Tamura representation
  - Coarseness
  - Contrast
  - Directionality
  - Linelikeness
  - Regularity
  - Roughness

MUVIS- Multimedia Browsing, Indexing and Retrieval System

- MUVIS supports content-based video (with audio) and image indexing and retrieval
- 3 types of databases
  - *Video Database –vdbs*: Containing video clips, keyframes and associated feature information
  - *Image Database –idbs*: Containing images and associated feature information
  - *Hybrid Database –hdbs*: Containing video clips, keyframes, images and associated feature information



MUVIS


Query item
Feature Extraction
Features
End User
Display Results
Best Matches
Similarity Measurement
Multimedia Items
Features
On-line
Off-line
Multimedia Items
Feature Extraction
Multimedia Database
Other Sources

Example of MUVIS

Ground Truth Method

- A group of **10** people who does not have any expertise on image/video processing or multimedia retrieval evaluated the retrieval performances from each query in each experimental case.

Grade	Subjective Meaning
0	No similarity / Not related
1	Slightly related
2	Related
3	Similar
4	Fairly similar
5	Same / Almost identical

Table 1: The subjective meanings of the evaluation grades

Rank	2	3	4	5	6	7	8	9	10	11	12
Grade	5	3	4	0	3	2	1	1	1	2	3

$$P = \sum_{i=1}^{12} G_i \cdot W_i \,, \qquad (1)$$

$$QP = \frac{\sum_{j=1}^{NP} P_j}{NP} \quad \text{and} \quad OQP = \frac{\sum_{k=1}^{N} QP_k}{N} \,, \qquad (2)$$

P: Performance Value
QP: Query Performance Value
OQP: Overall Query Performance Value

Experiment I: Color-based image retrieval

- Dataset:
  - Base Image database: 1594 uncompressed color images with various sizes and color bit depths
  - 7 compressed databases whose images are JPEG compressed with a unique compression ratio
- Uncompressed image database get the best performance
- Image retrieval based on HSV color histogram performs better than retrieval based on YUV color histogram in the uncompressed domain, and vice versa in the compressed domain.

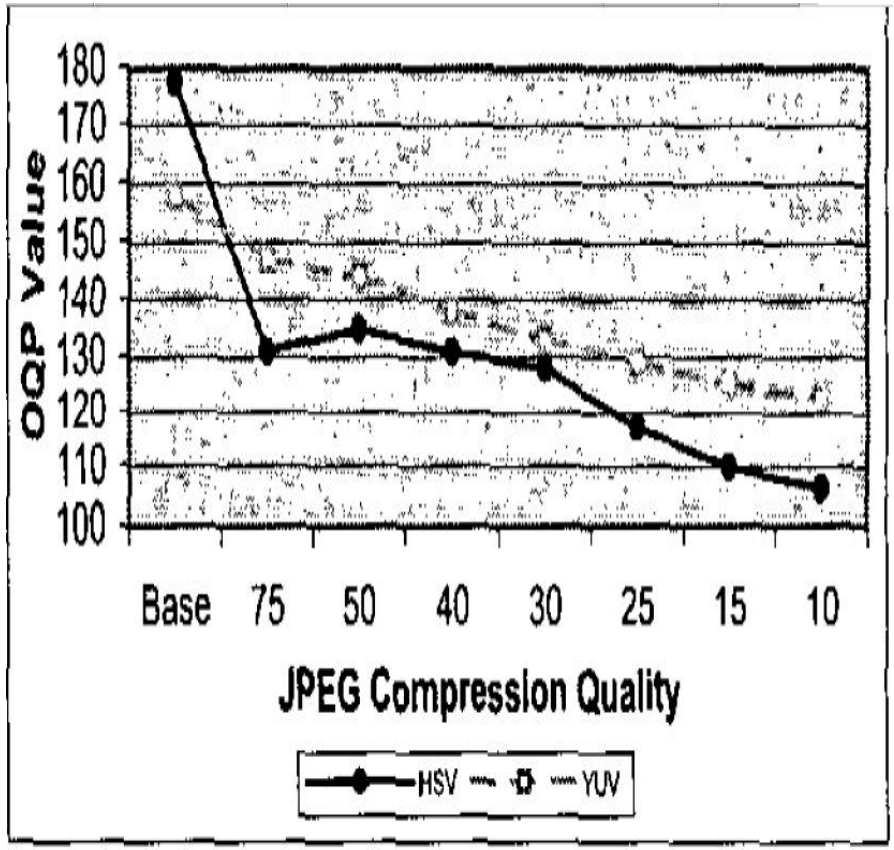


Figure 2: Image retrieval performance based on color histogram

Experiment II: Color-based video retrieval

- Dataset:
  - Base Video Database: 300 video clips in AVI format
  - Two compressed databases, one is compressed by MPEG-4 and the other is compressed by H.263+
- Video retrieval based on HSV and YUV color histogram in MPEG-4 compressed databases performs better compared to H.263+ compressed databases
- Retrieval performance from H.263+ compressed database at lower bit rates is more stable

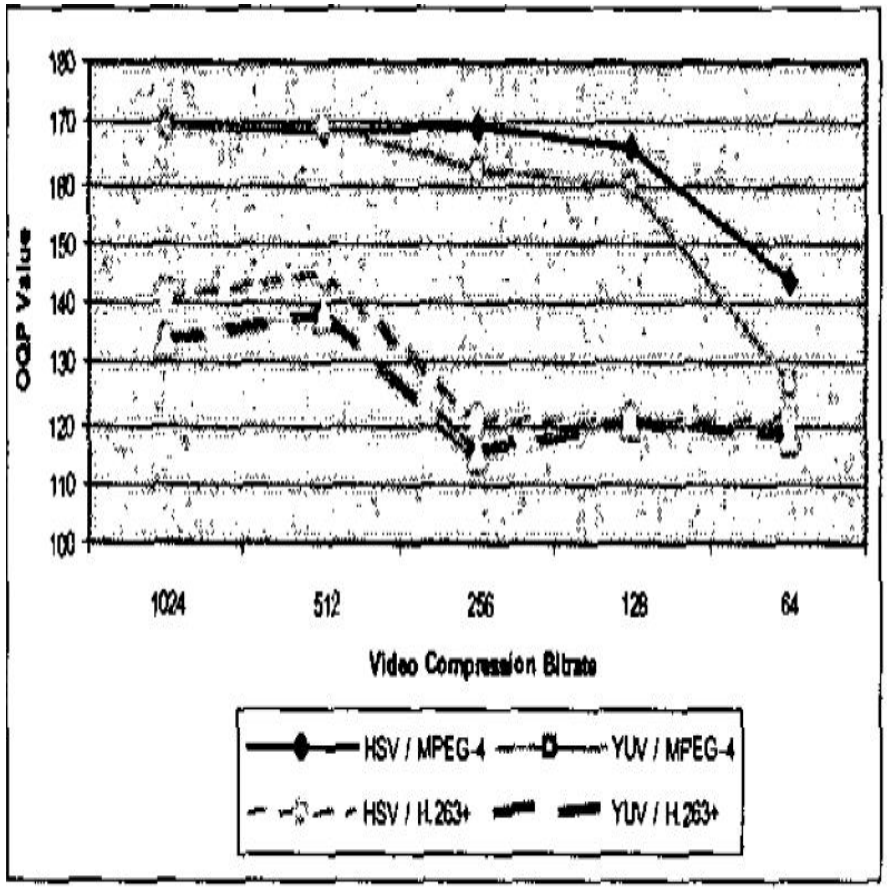


Figure 3: Video retrieval performance via color histogram

Experiment III: Texuture-based video retrieval

- Datasets:
  - Texture Image Database: 1512 uncompressed gray-scale images with 166*166 pixels
  - 7 compressed databases whose images are JPEG compressed with a unique compression ratio
- Image retrieval based on texture features gives more robust performance results than retrieval based on color features
- Using Gray level co-occurrence matrix feature extraction technique gives higher image retrieval performance than using Gabor wavelet transform

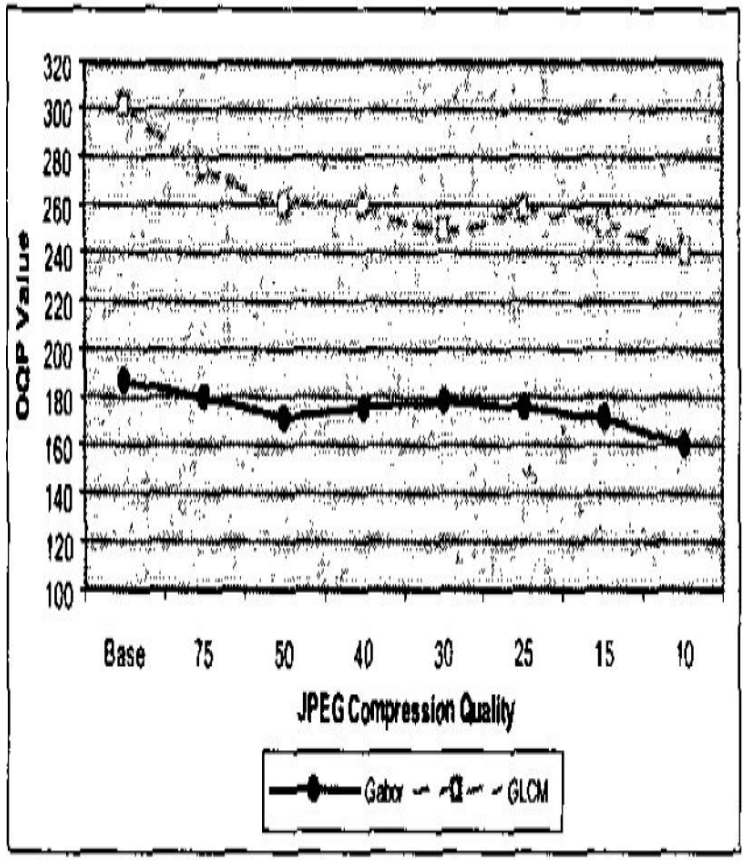


Figure 4: Image retrieval performance via texture features

Conclusion and Interpretation

- JPEG effect on color domain
  - JPEG encoding works on YUV color domain, and any non-linear transformation into any other color domain such as HSV may cause severe degradations (such **as** saturation, loss of resolution,etc.) on the color information
- JPEG effect on texture features
  - The reason of robustness can be insignificant texture information loss due to degration in color domain caused by JPEG compression
- MPEG-4 and H.263+ effect on video
  - Practically the compression may change the key-frame selection of the video sequence and this change could affect the retrieval result