Compression effects on color and texture based multimedia indexing and retrieval

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Background and Motivation

- Larger 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
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
Example of MUVIS
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.

Table 1: The subjective meanings of the evaluation grades

<table>
<thead>
<tr>
<th>Grade</th>
<th>Subjective Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No similarity / Not related</td>
</tr>
<tr>
<td>1</td>
<td>Slightly related</td>
</tr>
<tr>
<td>2</td>
<td>Related</td>
</tr>
<tr>
<td>3</td>
<td>Similar</td>
</tr>
<tr>
<td>4</td>
<td>Fairly similar</td>
</tr>
<tr>
<td>5</td>
<td>Same / Almost identical</td>
</tr>
</tbody>
</table>

\[
P = \sum_{i=1}^{12} G_i \cdot W_i ,
\]

\[
QP = \frac{\sum_{j=1}^{N_P} \rho_j}{NP}
\]

\[
OQP = \frac{\sum_{k=1}^{N} QP_k}{N}
\]

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.

![Image retrieval performance based on color histogram](image-url)
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: Texture-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 degradation 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