TWO APPLICATIONS

(LECTURE 38)

- DATA MINING
- FACE RECOGNITION
Applications of Wavelets in Data Mining
Improve the efficiency of Multi-level Surprise and Trend Queries
Data Representation as a Matrix

\[ \tilde{X} = M \times N \]
(1) Efficient Storage

(2) Efficient Retrieval

(3) Can be easily modified
Singular Value Decomposition (SVD)

\[ X = U \Lambda V^T \]

\( r \) = Rank of Matrix \( X \)
(1) Complexity of reconstruction $N \times M$
(2) \( X \) is not updated

Recompute the whole matrix again
Split Operation

AX_i

H

↓2

AX

G

↓2

D_i
Merge Operation

$A X_{i+1}$

$D X_{i+1}$
Properties

(i) Perfect reconstruction

(ii) Power complementary

(iii) Size of each node decreases
Assumptions

(i) Split and merge operations incur negligible cost

(ii) Cost due to disk I/O operation
Optimal TSA tree

Store only the leaf nodes
(1) Node Dropping

Exploit the Orthogonality property
$\|X - \hat{X}\|^2 = \sum_{\text{node} \in S} \|\text{node}\|^2$

Use a greedy algorithm

$\text{norm}^2(\text{node})$

$\text{size}(\text{node})$
(2) Co-efficient Dropping
- Store co-efficients
- Store indexes
Application of Wavelets in Data Mining

Instructor: Prof V. M. Gadre

Kunal Shah (09307001)
Arka Chowdhury (09307402)
Reference

Reference

Stock prices of SBI taken from Yahoo stock.
Hyperlink:
http://finance.yahoo.com/q/hp?s=SBIN.NS&a=09&b=27&c=2006&d=09&e=26&f=2009&g=d
FACE RECOGNITION THROUGH WAVE-PACKET ANALYSIS

Instructor: Prof. V. M. Gadre

Presented by: Shah Ronak
# Experimental Results

<table>
<thead>
<tr>
<th>Exp</th>
<th>Number of Images used in Learning/class</th>
<th>Total Images used in learning</th>
<th>Total number of query images</th>
<th>Number of images matched to the native class</th>
<th>Accuracy (±1.25%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>40</td>
<td>80</td>
<td>66</td>
<td>82.5%</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>60</td>
<td>80</td>
<td>64</td>
<td>80.0%</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>80</td>
<td>80</td>
<td>64</td>
<td>80.0%</td>
</tr>
</tbody>
</table>
TYPICAL ARCHIEVAL RESULT
(CBIR INTERFACE)

QUERY IMAGE

RETRIEVED IMAGES
TYPICAL FACE IMAGES FOR ONE SUBJECT
FROM YALE** FACE DATABASE

** can be downloaded from: http://cvc.yale.edu/projects/yalefaces/yalefaces.html For non-commercial use only
DISTANCE METRIC

➤ Why not Euclidean?

➤ Metric based on Bhattacharyya Distance

\[
D(V_k, V_l) = \sum_{f=1}^{17} D_f(V_k, V_l)
\]

\[
D_f(V_k, V_l) = \frac{1}{4} \frac{(\mu_{fk} - \mu_{fl})^2}{(\sigma_{fk}^2 + \sigma_{fl}^2)} + \frac{1}{2} \ln \left( \frac{\frac{1}{2} (\sigma_{fk}^2 + \sigma_{fl}^2)}{\sqrt{\sigma_{fk}^2 \sigma_{fl}^2}} \right)
\]
FEATURE VECTOR EXTRACTION

Approximation Subspace (4 features)

Mean ($\mu_1$) & Variance ($\sigma_1^2$)

Mean ($\mu_2$) & Variance ($\sigma_2^2$)

Detail Subspaces (15 features)

Mean ($\mu_i$) ‘zero’ & hence Variance ($\sigma_i^2$) only
SUBSPACES OBTAINED AT SECOND LEVEL OF DECOMPOSITION (contd..)

DETAIL SUBSPACES
SUBSPACES OBTAINED AT SECOND LEVEL OF DECOMPOSITION

APPROX

DETAIL SUBSPACES
MAGNITUDE RESPONSES AT SECOND LEVEL OF DECOMPOSITION (contd..)

Filter 3 at second level of decomposition

Filter 4 at second level of decomposition

HPF Magnitude Response  BPF Magnitude Response
MAGNITUDE RESPONSES OF FILTERS AT SECOND LEVEL OF DECOMPOSITION

Filter 1 at second level of decomposition

Filter 2 at second level of decomposition

LPF Magnitude Response  BPF Magnitude Response
MAGNITUDE RESPONSES OF FILTERS

LPF Magnitude Response

HPF Magnitude Response
**FILTERS IN ACTION**

Lowpass filter used for face recognition task

![LPF Impulse Response](image1)

Highpass filter used for face recognition task

![HPF Impulse Response](image2)

<table>
<thead>
<tr>
<th>Filter</th>
<th>Impulse Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPF</td>
<td>0.05  -0.15  0.20  0.40  0.80  0.40  0.20  -0.15  0.05</td>
</tr>
<tr>
<td>HPF</td>
<td>-0.06  -0.04  0.10  0.40  -0.80  0.40  0.10  -0.04  -0.06</td>
</tr>
</tbody>
</table>
TWO-LEVEL WAVE-PACKET DECOMPOSITION

FACE IMAGE

APPR

DETAIL

APPR

DETAIL

DETAIL

1st LEVEL

2nd LEVEL

DETAIL
Traditional filter-bank structure

For Image

Image → Rows

HPF, |2 → HH

LPP, |2 → HL

HPF, |2 → LH

LPD, |2 → LL

Columns

Rows
BLOCK DIAGRAM
(MATCHING)

Query Image → Same algorithm → Feature Vector → Matching

BEST MATCH (ES)
BLOCK DIAGRAM
(PROTOTYPE LEARNING)

Image/Video

[Not part of this discussion!]

Face Detection

Subband Decomp

Feature Extraction

Learned Prototypes

Feature Normalization
APPROACHES

➤ Geometric approach

➤ Feature based approach
Why Face Recognition? (contd..)

- Automatic character (actor) recognition

- Image and Video database management for efficient archival
Why Face Recognition?

- Bio-metric Recognition?
- Surveillance
  - Activity Tracking & Recognition
  - Abnormality Detection
REFERENCES (contd..)


REFERENCES
