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Content Based Image Retrieval

Fundamentals & State-of-the-art

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Outline

- **Fundamentals:**
  - Motivation
  - History
  - CBIR framework
  - Features
  - Similarity measure
  - Demo 1 : VC-bir website!
- **State-of-the-art:**
  - Refine your results! : Concept of Relevance Feedback
  - Demo 2 : RF-CBIR system
  - Applications

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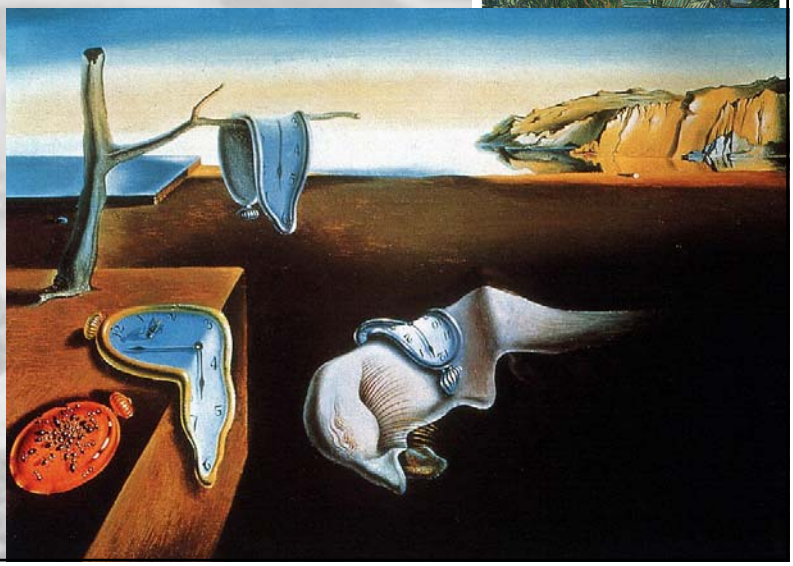
Motivation

- Suppose you see these masterpieces somewhere,
- You want to know more about it,
- but you know nothing about it !! ☹
- Can google/image help you out !?
- What can help you out !?



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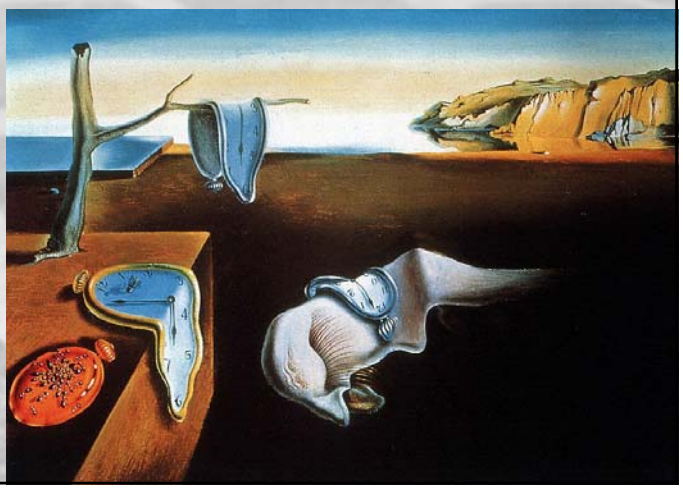
Motivation

- Current “text to image” retrieval system cannot help you out!
- Let’s turn to CBIR system!



Persistence of Memory
Salvador Dali ,1931

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History

- Originated in 1992, by T. Kato
- Since then, the term has been used to describe the process of retrieving desired images from a large collection on the basis of syntactical image features.
- The techniques, tools and algorithms that are used originate from fields
  - statistics,
  - Machine learning,
  - signal processing,
  - computer vision. Etc.
- CBIR aims at avoiding the use of textual descriptions and instead retrieves images based on their visual similarity to a user-supplied query image or user-specified image features.

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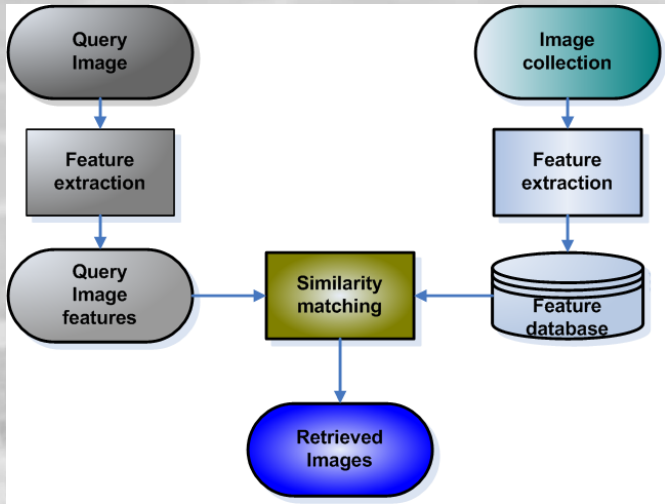
CBIR framework

- **Off-line:**
  - Build the image database for specific application
  - Select reasonable features from “feature supermarket”
- **On-line:**
  - User submits image to CBIR system
  - Similarity measure
  - Rank the similarity of all images in database
  - Return result list to user



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Features

- Compact representations of image
- Three main features:
  - Color
  - Texture
  - Shape

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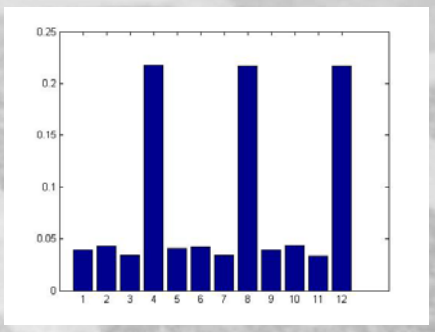
Feature: Color

- Color
- color histogram : identifies the proportion of pixels within an image holding specific values (that humans express as colors).
- one of the most widely used techniques because it does not depend on image size or orientation.
- Example: Color histogram



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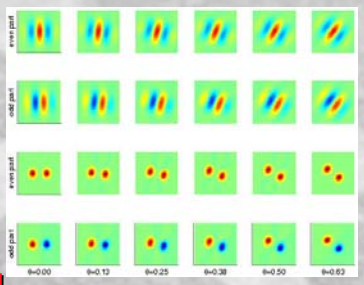
Feature: Texture

- Texture measures look for visual patterns in images and how they are spatially defined.
- The identification of specific textures in an image is achieved primarily by modeling texture as a two-dimensional gray level variation.
- The relative brightness of pairs of pixels is computed such that degree of contrast, regularity, coarseness and directionality may be estimated .
- Example: Gabor filter bank (strong feature extraction, similar to human visual perception)



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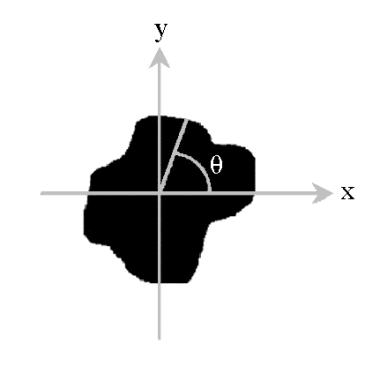
Feature: Shape

- The shape of a particular region that is being sought out.
- Shapes will often be determined first applying segmentation or edge detection to an image.
- Example: Fourier Contour Descriptor



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Similarity measure

- Euclidean distance
- M-distance
- Chi-square distance
- Fuzzy Hamming Distance (Anca Ralescu, 2004)
- Canonical Correlation Analysis, etc…

1-norm distance $= \sum_{i=1}^{n} |x_i - y_i|$

2-norm distance $= \left(\sum_{i=1}^{n} |x_i - y_i|^2 \right)^{1/2}$

p-norm distance $= \left(\sum_{i=1}^{n} |x_i - y_i|^p \right)^{1/p}$

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Demo 1 : VC-bir website!

- **Let's rock CBIR!**

- http://www.cs.uc.edu/~fangcg/php/cbir.php

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State-of-the-art:

- What the smart researchers in this planet are doing?
  - Microsoft Research
  - Google
  - UIUC, Berkeley…
- What can you, a brilliant UC graduate student, contribute to this hot research area?
  - Machine learning
  - Large scale distributed network for retrieval computing
  - Cognitive science…

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Concept of Relevance Feedback

- **Refine your Refine your results! : Concept of Relevance Feedback**

IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, VOL. 8, NO. 5, SEPTEMBER 1998

Relevance Feedback: A Power Tool for Interactive Content-Based Image Retrieval

Yong Rui, Thomas S. Huang, *Fellow, IEEE*, Michael Ortega, and Sharad Mehrotra

Concept of Relevance Feedback

- Previous efforts have relatively ignored:
  - 1) the semantic gap between high-level concepts and low-level features,
  - 2) subjectivity of human perception of visual content.
- *interactive* retrieval approach.
- the user's high-level query and perception subjectivity are captured by dynamically updated weights based on the user's feedback
  - **Machine centered and Human centered !!**

Concept of Relevance Feedback

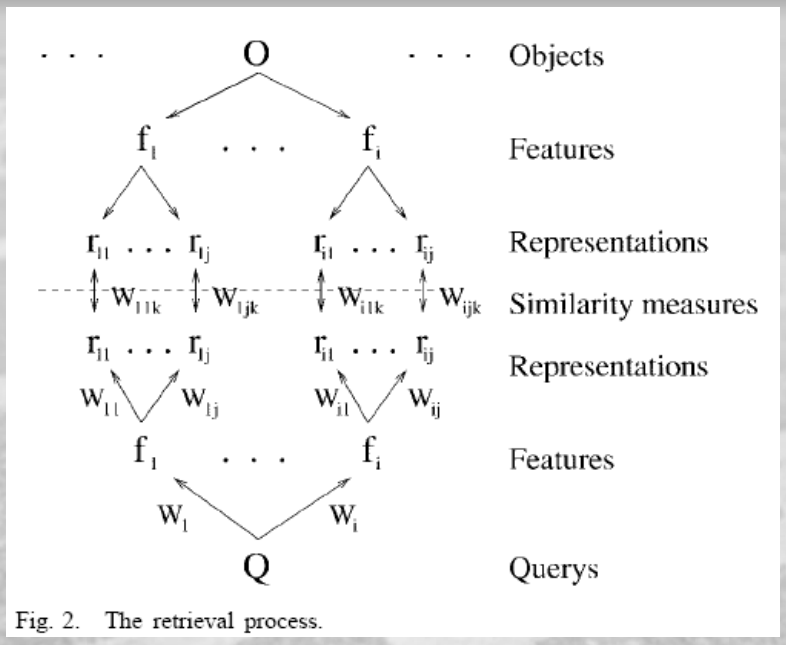

Fig. 2. The retrieval process.

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Key point: Weight Update!

- **User's feedback:**

$$
\begin{aligned}
&= 3, && \text{if highly relevant} \\
&= 1, && \text{if relevant} \\
Score_l &= 0, && \text{if no opinion} \\
&= -1, && \text{if nonrelevant} \\
&= -3, && \text{if highly nonrelevant.}
\end{aligned}
$$

- **Weight update:**

$$
\begin{aligned}
W_{ij} &= W_{ij} + Score_l, && \text{if } RI_l^{ij} \text{ is in } RT \\
&= W_{ij} + 0, && \text{if } RI_l^{ij} \text{ is not in } RT \\
l &= 0, \cdots, N_{RT}.
\end{aligned}
$$

- **Weight normalization:**

$$W_{ij} = \frac{W_{ij}}{W_{Tij}}.$$

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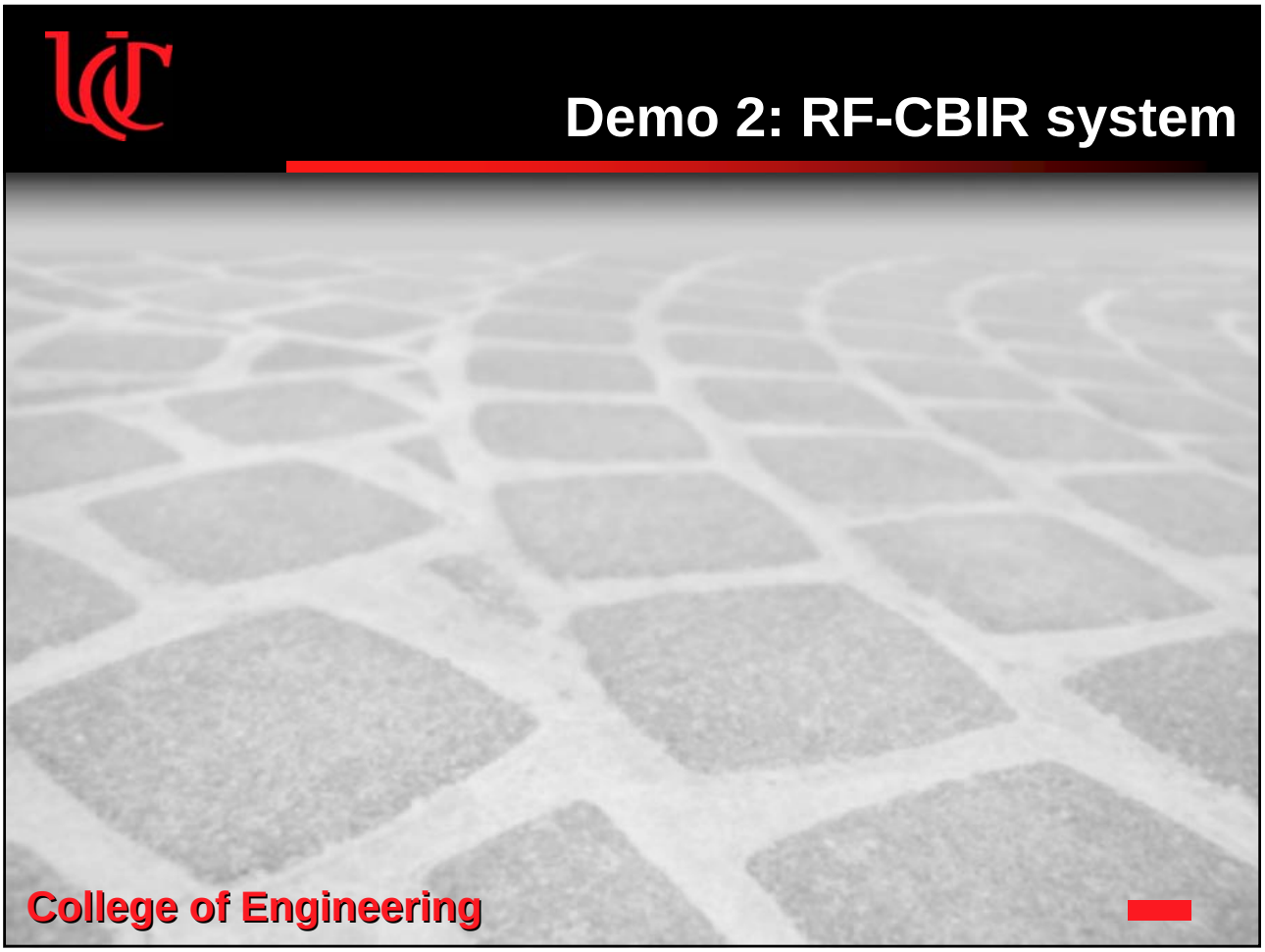
Demo 2: RF-CBIR system
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Some applications

- **Face Identification RF-CBIR system,**
  - **by National Lab for Pattern Recognition, Inst. Of Automation, Chinese Academy of Sciences;**
  - **Large scale face image database (million);**
  - **Retrieval time: <1.3 second on PC.**

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Acknowledgement

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