Image Processing

The Applications Just Keep Getting More Exciting

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A Brief Biographical Sketch

- Bachelors Degree in Physics at the University of California at Berkeley
- Masters and Sc.D degrees at the Massachusetts Institute of Technology
- Became a Full Professor at the Georgia Institute of Technology
- Has taught at universities in France, China, Spain, and Korea (CAU, KU, SNU)

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I always welcome visitors and my door is always open (weather permitting).

Please stop by just to talk, or to get some help or get advice … or maybe just to practice your English and teach me a some Korean

What is Image Processing?

- Today, Image Processing is much more rich and dynamic and exciting than the manipulation of pictures and images using Photoshop.
- Image Processing Problems of Today Include
  - Compression (High-Definition and Beyond)
  - Expansion (Super-Resolution)
  - Understanding (Vision, Context Aware Devices)
  - Analysis (Surveillance, Forensics, Personalization, Gaming)
  - Searching (Mining)
  - Classification (Cataloging)
Emerging Signal Processing Applications
Las Vegas, January 2012

- 3D technology for gaming, tele-presence
- Gesture recognition for games and natural user interfaces
- Digital photography
- 4G wireless
- Robotics
- Multimedia tablets
- SP in automobiles: speech interfaces, cameras
- Voice search
- SP with multicore processors
- IPTV

Quiz

- We all are familiar with the terms Megabyte, Gigabyte, and Terabyte

- What is an Exabyte?
  One Exabyte = $2^{60}$ bytes
  $\approx 10^{18}$ bytes
  $= 1,000,000,000,000,000,000$ bytes
  $= 1,000,000,000$ Gigabytes

- What is the significance of this number?

The Economist, Feb 25, 2010

- "If you put all the data in the world onto CDs and stack them up, the pile would stretch from the Earth to beyond the moon."

- "The world’s technological infrastructure has reached 295 Exabytes in 2007, a reflection of the world’s almost complete transition into the digital realm."

- It is estimated that from 2009 to 2020, the size of the digital universe will increase by a factor of 44 – which will take us into the zettabytes.

- Much of this data is in the form of images and video.

Facebook

- Facebook, a social-networking website, is home to more than 80 billion photos (2009)

- Storing, locating and extracting value from high volumes of data will become increasingly complex.
Image and Video Processing Applications

- Surveillance
- Environment Awareness
- Forensics
- 3-D Video
- Virtual Reality
- Gaming
- Video Conferencing / Tele-presence
- Medical Imaging

Surveillance

Wide angle video surveillance camera within a bank or museum.

Intelligent Vehicles – Lane Detection

http://www.youtube.com/watch_popup?v=VnrqYqXYF7k&vq=medium

Super-Resolution

- A very low resolution image
Super-Resolution

- Multiple low-resolution images.

Super-Resolution

- Super-Resolution from Multiple low-resolution images.

Image Processing in Art History

- A computer program has been developed to analyze aspects of Van Gogh and other paintings that can't be seen by the eye.
- Forensic investigations reveal previously unavailable details about the masters' raw materials.
- Automatically creates a virtual fingerprint that can be used by historians to place a painting within the timeline of an artist's work.

Image Duplication, Forgery, Manipulation

Determining the validity of photographs (and videos) has an important role in many areas:

- Forensic investigation
- Criminal investigation
- Digital Rights Management (DRM)
- Surveillance systems
- Intelligence services
- Medical imaging
- Journalism
Image Tampering Has a Long History

- In today's digital age, it is possible to change, very easily, the information represented by an image without leaving any obvious traces of tampering.

In this doctored photograph, Adolf Hitler had Joseph Goebbels removed from the original photograph. It is unclear why Goebbels fell out of favor with Hitler.

Image Forensics

- Image forensics is a burgeoning research field and promise a significant improvement in forgery detection in the never-ending competition between image forgery creators and image forgery detectors.

Stalin routinely removed his enemies from photographs. Here, a commissar was removed from the original photograph after falling out of favor with Stalin (circa 1930).

Medical Imaging

- X-rays, computed tomography (CT), ultrasound, magnetic resonance imaging (MRI), radionuclide imaging.
- There are many important problems such as image enhancement and detection for diagnoses.

Ultrasound image of a fetus

Sagittal T\textsubscript{1}, MRI image of the paediatric head

Planar X-ray of ankle and
Extended foot

Advanced Imaging Systems

The Terminator
The Pentagon wants troops to see dangers lurking behind in real time, and be able to tell if an object a km away is a walking stick or an AK-47. The eyepiece will include "high-resolution computer-enhanced imagery as well as task-specific non-image data."

Plenoptic (light field) Camera by Lytro
This camera is 110 mm long and 40 mm square. Image processing on the captured light-field data allows one to automatically change the focus.

The Plenoptic camera can capture a complete light field, allowing for dynamic focus and depth of field controls.
A Lytra Photo

- Example of a Lytro photo. With the click of a mouse, the photo’s focal point can be automatically changed.

Multiple Color Filter Aperture (MCA) Camera

- The MCA computational camera is a research project by Dr. Paik and his students in the *Image Processing and Intelligent System Laboratory* for auto-focusing and depth estimation.

Image/Video Processing for Gaming

- Full Body Motion Capture
- Face Recognition
- Controller Free Entertainment

Recognition

- Gesture recognition can be used in a visual or sensor-based control system.
- Hand detection and tracking is the front-end of these systems.

- Face Recognition can be used for device personalization, secure entry, criminal investigation.
- Face.com has software that can identify people from internet photos.
Many Players and Alliances Being Formed

Thank You