Image Processing and Computer Vision

Ranga Rodrigo
Department of Electronic and Telecommunication Engineering
University of Moratuwa
Sri Lanka

Mathematics Society Talk

February 24, 2009
Outline

1. Introduction
2. Applications
3. Vision in Automation
4. Software Tools
5. Examples of State-of-the-Art
6. Summary
What Is Image Processing?

Image Processing

In image processing, we attempt to manipulate the input image to obtain a “better” image.
What Is Computer Vision?

Computer Vision

In computer vision, we analyze the input image and obtain an understanding or make a decision.
What Is Computer Vision?

- The goal is the emulation of the visual capability of human beings using computers.
- In other words, computer vision is making the machine see as we do!
- It is challenging.
- Steps:
  1. Image acquisition
  2. Image manipulation
  3. Image understanding
  4. Decision making
Main Driving Technologies

- Signal processing.
- Multiple view geometry [2].
- Optimization.
- Hardware and algorithms.
Applications

Automotive:
- Lane departure warning systems.
- Head tracking systems for drowsiness detection.
- Driver assistance systems.
- Reading automobile license plates, and traffic management.

Photography:
- In camera face detection [5], red eye removal, and other functions.
- Automatic panorama stitching [1].

¹(From http://www.cs.ubc.ca/spider/lowe/vision.html)
Applications

- Movie and video (a very big industry):
  - Augmented reality.
  - Tracking objects in video or film and solving for 3-D motion to allow for precise augmentation with 3-D computer graphics.
  - Multiple cameras to precisely track tennis and cricket balls.
  - Human expression recognition.
  - Software for 3-D visualization for sports broadcasting and analysis.
  - Tracking consistent regions in video and insert virtual advertising.
  - Tracking for character animation.
  - Motion capture, camera tracking, panorama stitching, and building 3D models for movies.
Camera Tracking

Source: http://www.2d3.com/capability

Show 2d3 video.
Applications

- **Games:**
  - Tracking human gestures for playing games or interacting with computers.
  - Tracking the hand and body motions of players (to control the Sony Playstation).
  - Image-based rendering, vision for graphics.

- **General purpose:**
  - Inspection and localization tasks, people counting, biomedical, and security. etc.
  - Object recognition and navigation for mobile robotics, grocery retail, and recognition from cell phone cameras.
  - Laser-based 3D vision systems for use on the space shuttles and other applications.
  - Image retrieval based on content.
Applications

- **Industrial automation (a very big industry):**
  - Vision-guided robotics in the automotive industry.
  - Electronics inspection systems for component assembly.

- **Medical and biomedical (maturing):**
  - Vision to detect and track the pose of markers for surgical applications, needle insertion, and seed planting.
  - Teleoperations.
  - Quantitative analysis of medical imaging, including diagnosis such as cancer.

- **Security and biometrics (thriving):**
  - Intelligent video surveillance.
  - Biometric face, fingerprint, and iris recognition.
  - Behavior detection.
Minimal Invasive Surgery

Areas of Advancement

- Hardware.
- Image segmentation.
- 3-D reconstruction.
- Object detection.
- Navigation.
- Scene understanding.
What’s needed?

- cameras
- software
- actuators
Cameras

- Camera, and a frame grabber.
- IEEE 1394 or USB cameras.
- Ethernet cameras.
Vision in Automation


Source: http://www.matrox.com/imaging/products/vio/home.cfm
Software Tools

- Octave or Matlab.
- C or C++ with a library such as OpenCV.
Image Processing using Octave or Matlab

- Simple and quick.
- A lot of library functions.
- Interpreted.
Octave Examples

- Image reading and writing.
- Histograms.
- Filtering.
Image Processing using OpenCV

- Power of C++.
- Well coded.
OpenCV Examples

1. Image reading and writing.
2. Edge detection.
3. Template matching.
4. Capturing video.
Examples of State-of-the-Art

Segmentation Using Graph Cuts [4]
3-D Reconstruction

Can we obtain a 3-D view of a scene, given only a set of (2-D) images?
Yes. Using multiple view geometry, we can reconstruct a scene.
Show Leibe et al. video [3].
Object Detection: Face Detection
Navigation: Sanford’s Robot Stanley

Show video.
Conclusion

- Vision-based automation is promising.
- Solutions are simple in a controlled environment.
- State-of-the-art is very interesting.
Thank you.

OpenCV examples, and Octave examples are here: http://www.ent.mrt.ac.lk/ ranga/publications.html


