CS 436
Computer Vision Fundamentals

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Office Hrs: M 10am-11am
 W 10am-11:am
 Th 3pm-4pm

Course Status

- Elective for Senior/Graduate students
- Prerequisites:
  - Strong programming background
  - Mathematics Background
    - Required
      - Matrix Manipulation, Calculus
    - Will be helpful, but not assumed
      - Probability, Random Processes, Signal Processing...
Goals

- Basic Goal: Generate excitement about CV
- Introductory theory & applications of CV
- Demonstration of simple exciting applications
- Ability to write programs to solve CV problems
- Examples of CV Systems
- Intro to some current research topics

Text

- Computer Vision
  Linda G. Shapiro, George C. Stockman
  Prentice Hall, 2001
- Additional course notes and reading material will be available through the course website.
- Programming Environment:
  - C/C++ and MATLAB
Lectures
- 20 sessions, 100 minutes each
- 1 in-class midterm, 1 final exam
- 50 minutes each week for programming aspects of the course
- No grade for attendance

Grading
- 40% projects and programming assignments
- 10% assignments/homework
- 5% reading assignments
  - Graded through class participation/quizzes
- 20% mid-term
- 25% final exam (non-comprehensive)
Cheating/Plagiarism

- Will not be tolerated...

Course Website

- Tool to keep all reading links, additional information in one place
- Lecture notes and slides will be available
- http://web.lums.edu.pk/~sohaib/cvf-fall02.htm
What is Computer Vision

“The goal of Computer Vision is to make useful decisions about real physical objects and scenes based on sensed images”

Computer Vision Area

- Integration of several areas
  - Image processing
  - Statistical inference
  - Machine intelligence
  - Decision theory…

- Teaching methodology
  - Cover some basic areas
  - Breadth vs Depth
  - Show lots of examples
Module 1 (4 Sessions)

- Introduction (1)
- Transformations and Imaging Geometry (3)

2D Transformations

Module 1 (4 Sessions)

- Global Transformation Models
  - Affine, Projective, Bilinear

From http://wearcam.org (Professor Steve Mann)
Module 1 (4 Sessions)

- 3D Transformations
- Camera Models
- Camera Calibration

Module 1 (4 Sessions)

- Warping
  - Applying transformation to an image
  - Can be done for multiple images
Module 2 (6 Sessions)

- Basic Binary Operations
  - Thresholding, Morphology, Region Properties, Moments, Connected Component Labeling
Module 2

- Edge Detection
- Shape Representation, Hough Transform

Module 3 (6 Sessions)

- Pattern Recognition, Decision Theory
- Clustering
  - K-Means
  - Bayes Classifiers
  - MAP Estimation
  - EM Algorithm
  - Principle Component Analysis
  - Face Recognition
Module 3

- Background Subtraction
- Segmentation
Module 4 (4 Sessions)

- Motion
  - Brightness Constancy Equation
  - Optical Flow
    - Lucas-Kanade Method
    - Horn and Shunck Method
Module 4

- Global Motion Estimation / Image Stabilization
  - Affine Least-Squares Method
Programming Assignments

1. Image Warping
2. Edge Detection
3. Hough Transform for Lines
4. Clustering
5. Face Recognition
6. Segmentation
7. Lucas-Kanade Optical Flow
8. Global Motion Estimation & Image Stabilization

- All assignments may not be compulsory, depending on the ability of the students
Reading Assignment 1

- Chapter 1
- Section 2.5
- http://wearcam.org
- http://wearcam.org/research.html

Digital Images

- Images are essentially large matrices
- Gray scale images are 2D matrices
- Color images have 3 layers (R, G, B)
- Each cell of the matrix represents a pixel
- Each pixel is quantized to a set of values, e.g. from 0-255 (1 Byte per pixel)
PBM, PGM, PPM Format

- Portable Bit Map Formats
- Simple Image header in ASCII
- Image data in either ASCII or Binary
- .PGM for Grayscale images
- .PPM for Color (RGB) images

Programming Assignment 0

- Write Program to Read/Write BINARY .ppm & .pgm files
- Data will be available through course website
- Header

P2
# Created by IrfanView
128 128
255
47
55 58 58 58 58 58 58 56 56 55 54 53 52

- Magic Numbers for format identification
  - P2 - ASCII PGM
  - P3 – ASCII PPM
  - P5 – Binary PGM
  - P6 – Binary PPM
Tasks

- Implement both in MATLAB and C/C++
- MATLAB Introduction
  - [http://math.ucsd.edu/~driver/21d-s99/matlab-primer.html](http://math.ucsd.edu/~driver/21d-s99/matlab-primer.html)

Tasks

- Write functions
  - ReadBinPGM, WriteBinPGM, ReadBinPPM, WriteBinPPM
- Input: FileName
- Output: Matrix array containing image data
Tasks

1. Read in .pgm image file. Create negative of the image. Save it as another .pgm file
2. Read in a .ppm file. Switch color planes R↔G. Save it as another .ppm file
3. Read in a .ppm file. Save its R, G, B components as separate .pgm files

Due Date

- Tuesday 10th September
- Code printout of functions
- Sample output
- MATLAB help?