Computer Science 631
Multimedia Systems

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Today's topics

- Administrivia
- Motivation
- Course outline
- Introduction to digital imagery
- Special effects

The most important piece of information:

www.cs.cornell.edu/cs631

Administrivia

- Course staff: Ramin Zabih, Abhijit Warkhedi, Tibor Janosi
- Email: rdz,warkhedi,janosi@cs.cornell.edu
- MW will be lectures (Ramin)
  - F will be section (Tibor)
  - Section will introduce new material
    - Without going to section, it will be very hard to do the homework

Homework

- Three programming projects
  - Project 1 [2/22]: Morphing
  - Project 2 [3/29]: Mosaics from MPEG
  - Project 3 [4/28]: Face detection/recognition
    - Room for you to do research!
- No exams (unless you insist…)
- Grading will be typical of graduate courses
  - I expect to give mostly A's of some kind
  - This is **not** a promise

Doing the projects

- They will involve significant programming
- You should work in groups of two
- You are expected not to share code with anyone other than your partner
  - Cheating can earn you an F, even in a graduate course
- Programs must be in C under WindowsNT

Course motivation

- Digital “media” (audio, video) is everywhere
  - This was true even before the Web
- Numerous challenges and opportunities for computer science
  - How do you compress, process, store, transport these new data types?
  - What kind of new creative expressions do they make possible?

The focus of 631

- We will focus (almost) exclusively on the issues of processing images and video
  - Compression will be covered in sections, starting in week 2
- Our emphasis will be on algorithms
- We won’t do any 410-style analysis, but we’ll spend most lectures discussing various algorithms and their properties

Some related areas

- Graphics is concerned with producing an image from a description of the scene
- Computer vision is (classically) concerned with producing a description of the scene from an image
- What turns one image into another?
  - Vision, graphics, image processing

Course outline

- Three major pieces, each with a project

I. Distorting images in an interesting way

   Example: special effects

II. Building new images from old ones

   Example: Quicktime-VR

III. Finding things in images

   Example: counting people

Selected topics

- JPEG, MPEG and wavelets
- The image formation process
- Fast image processing (hardware and software)
- Face recognition
- Tracking moving objects
- Content-based image retrieval

Introduction to digital imagery

- To a computer, an image looks like a 2D array
  - A video is a time-indexed sequence of 2D arrays
- The individual elements are called *pixels*
  - For a black-and-white (grayscale) image, the pixels are *intensities*
  - 8-bit numbers, 0 = black, 255 = white
  - For color, 3 intensities (red, green, blue)

Image file formats

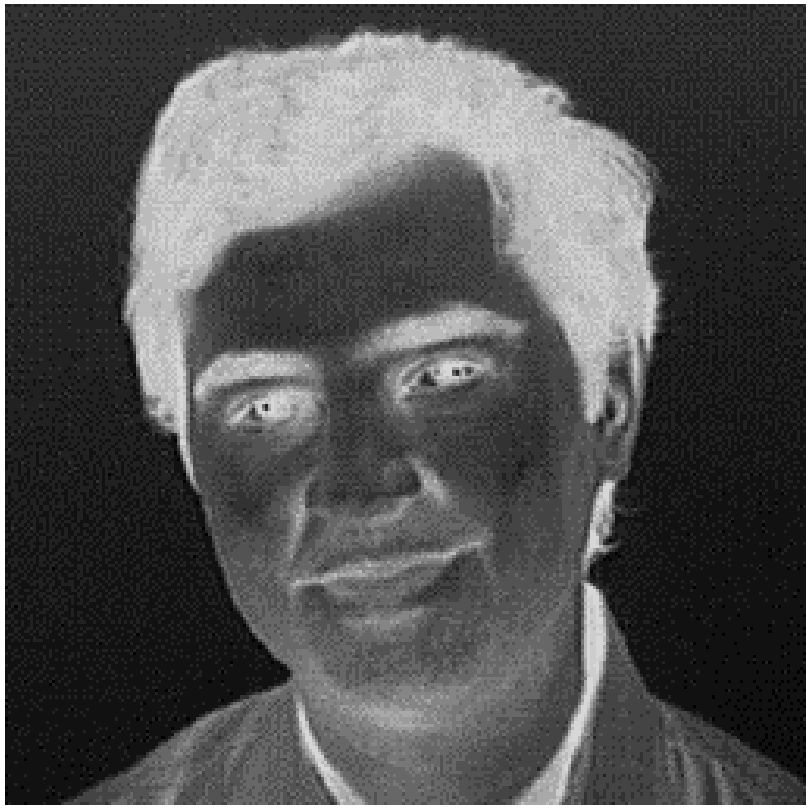
- The raw data is usually laid out in row-major order, with a header of some kind
  - Width, height, bytes per pixel
- Many different formats (i.e., BMP, GIF, TIFF), but little fundamental difference
  - For this course we will concentrate on the PGM (grayscale) or PPM (color) formats
  - We'll give you an image library to read and write images

Sample code: inverting an image

```
{
  int x,y;
  GrayImage in=imLoad(IMAGE_GRAY,“in.pgm”);
  int width=imGetWidth(in);
  int height=imGetHeight(in);
  GrayImage out=imNew(IMAGE_GRAY,width,height);
  for(y = 0; y < height; y++)
    for(x = 0; x < width; x++)
      imRef(out,x,y) = 255 - imRef(in,x,y);
  imSave(out,“out.pgm”);
}
```

Output

in.pgm



out.pgm

A simple variation

```
#define ALPHA .5
{
  int x,y;
  GrayImage in=imLoad(IMAGE_GRAY,“in.pgm”);
  int width=imGetWidth(in);
  int height=imGetHeight(in);
  GrayImage out=imNew(IMAGE_GRAY,width,height);
  for(y = 0; y < height; y++)
    for(x = 0; x < width; x++)
      imRef(out,x,y) = ALPHA * imRef(in,x,y);
  imSave(out,“out.pgm”);
}
```

Output

in.pgm

out.pgm

We can use this to implement a fade in

- Simplest special effect
  - Image appears from a dark background
- Let ALPHA go from 0 to 1
  - ALPHA = 0 gives you a black image
  - ALPHA = 1 gives the original image
  - How fast ALPHA changes controls the speed of the dissolve
- If we let ALPHA go from 1 to 0 we get a fade out

Various tools do this

- Examples: Adobe Premiere, or Avid
  - Many choices of special effects
  - Many of them just involve changing that 1 line of code!
- Movie and commercial special effects are done this way as well
- Hollywood has infinite $, so they often do “hand tuning”
  - But more and more is done automatically

Morphing

- Probably the most interesting special effect
  - One object “stretches” into another
  - Michael Jackson “Black and White” video
- Paper: T. Beier and S. Neely, *Feature-Based Image Metamorphosis*, SIGGRAPH ‘92
  - Authors are at Pacific Data Images
  - It’s amazing that this paper was published!