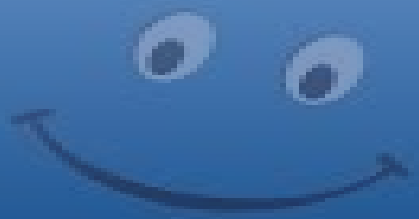
WELCOME to CS 545

Image Processing



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2015

Instructor

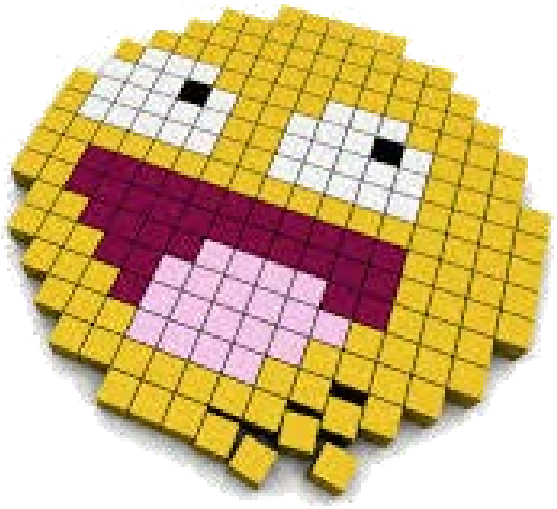
- Brent Dingle, Ph.D.
  - Office: JHSW, Room 219
  - Office Hours:
    - TBA
  - Office Phone: N/A
  - Email: dingleb@uwstout.edu

- Experience

2013- : University of Wisconsin - Stout
2012-2013: Kihon Games
2007-2012: Raytheon Missile Systems
1997-2007: Texas A&M University – College Station
1995-1997: Customer Development Corporation
1994-1995: Caterpillar
1990-1995: Bradley University

- Course Info: Check online D2L
  - Syllabus is also online

Welcome

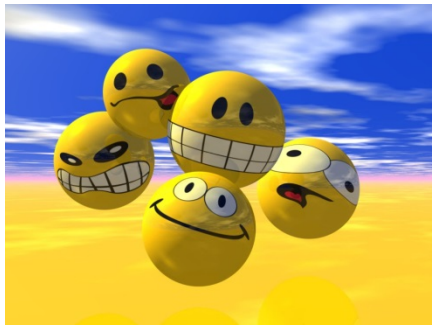


- Welcome
  to
  Image Processing !

- We will explore fun and exciting things!
  - Learning the mysteries of the digital image world

Prerequisites

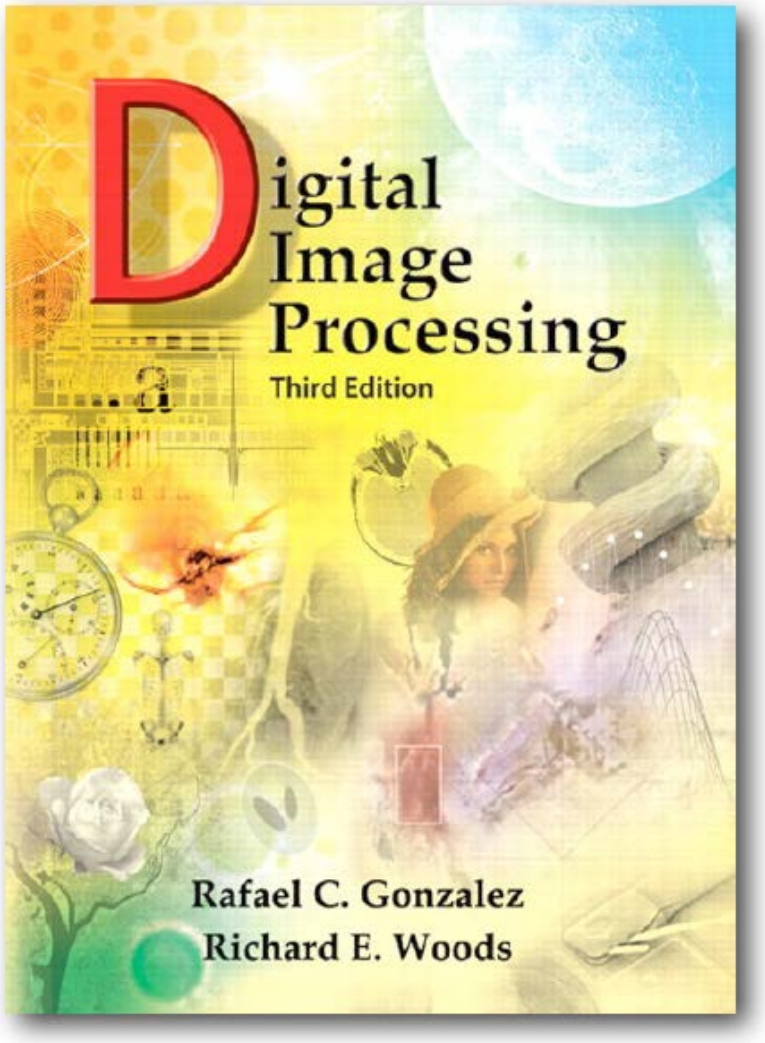
- Officially
  - MATH 255 (Differential Eqs)
  - MATH 275 (Linear Algebra)
  - STAT 332 (Probability and Statistics I)
  - CS 244 (Data Structures)



- Reality
  - Be able to solve math equations
  - Understand basics of probability and stats
  - General idea of/skills in computer programming

Suggested Book

- Digital Image Processing, 3rd Edition
  - R.C. Gonzalez and R.E. Woods
  - Pearson Prentice Hall
  - 2008



CS 345 versus CS 545

- Long term this is a dual listed class

- Currently only have Graduate Students
  - So only have CS 545
    - and duality is overcome by an instance of singularity

General Info

- Work and Grading
  - Homework Assignments = 15%
    - some may be worked on in-class
    - for this semester
      - all are graduate students
      - most homework will be loosely graded on level of attempt
  - Individual semester project = 75%
    - 3 parts
      - proposal = 5%
      - midpoint status = 30%
      - final status = 40%
        - » includes a final in-class presentation
  - Overall Performance/Quizzes/Other = 10%

Submitting Work

- Check online D2L *(aka Learn@UW-Stout)*
  - Dropboxes will be setup there for turn-in of work
    - Homework description should detail what is expected
    - Ask/email instructor if anything is unclear

Nature of Work

- Expected and Preferred use is
  - **HTML5 with**
    - **Canvas element, JavaScript, CSS**
    - **Examples will be provided to assist you**
  - What "can you use"
    - Ask instructor
      - Some **alternate options are:**
        - » **C++ and openGL**
        - » **Matlab**
        - » **WebGL, VRML**
      - BUT…
        - » no promises on how much "help" the instructor will give on optional tools

Expectations

- Summary examples will be shown on how to use HTML5 and JavaScript to do some things
- HOWEVER
- You will be expected to learn more on your own
  - The earlier you start, the better off you will be
  - Look through the posted lectures ahead of time

- *if you have concerns about this then discuss with the instructor AFTER class*

Responsibility

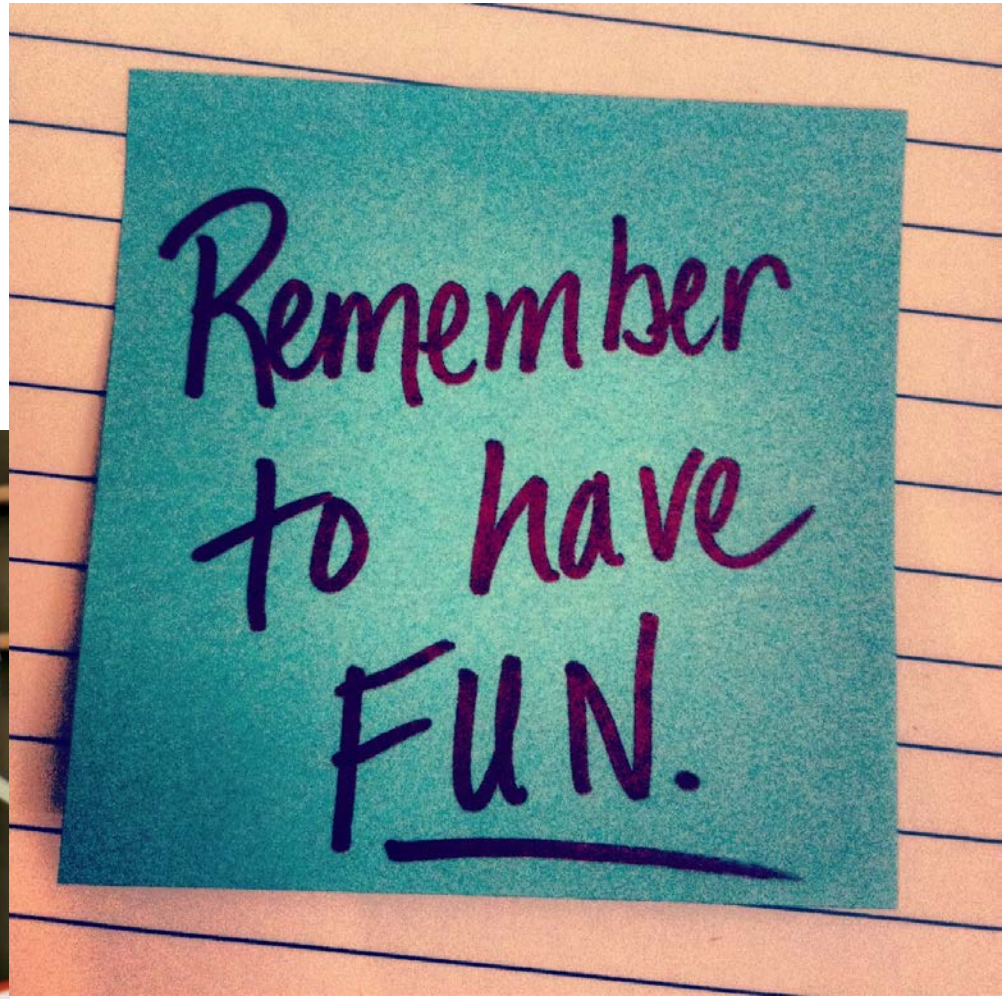
- This semester is only Graduate Students
  - Much of the initiative rests with you
  - Do not expect step-by-step instructions
  - You will be pointed in “a” direction
    - You should go beyond just “minimal” exploration on your own

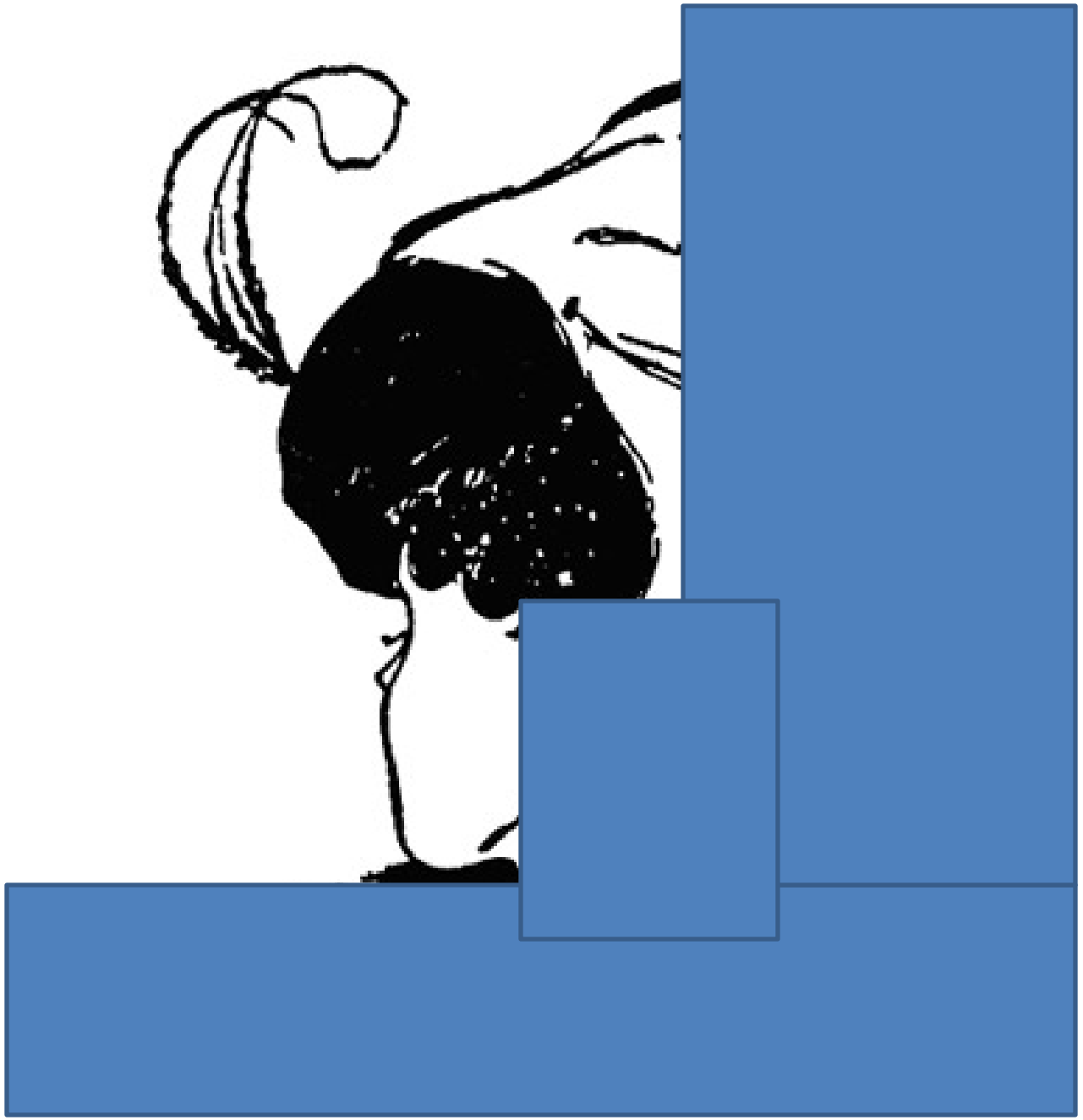
Objectives

- By semester end, you should
  - Understand the mathematical basis for image processing methods
  - Be able to implement image processing algorithms
  - Be able to select and apply image processing techniques in one or more applicable areas
  - Possess a broad understanding of the theoretical basis of image processing *

** Applies more to CS 545 students*

Class Character





Near Future: Things to Plan

End Course Description

- Any questions on the course framework?

- Next is actual course material

- continue…


THRILLVILLE
OFF THE RAILS

Lecture Objectives

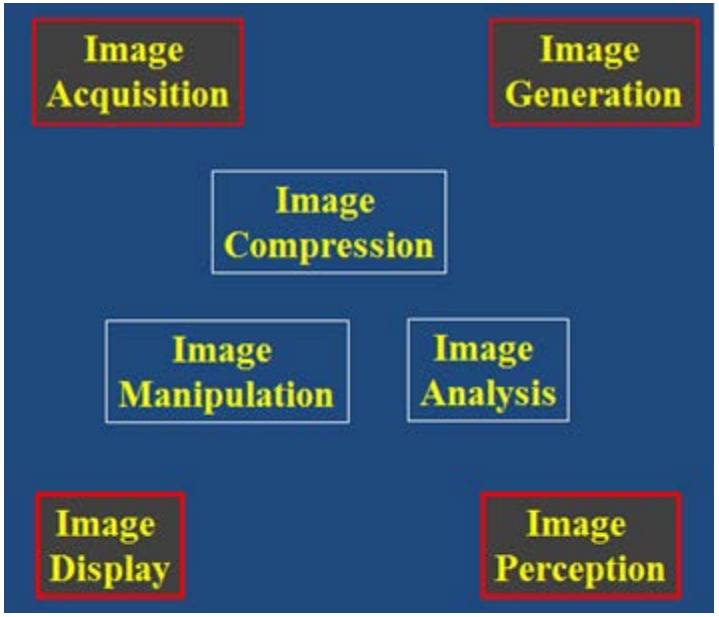
- Explore what image processing is about
  - Image
    Acquisition and Generation
    - Look at some related history
    - Consider related fields
    - Survey some application areas

Lecture Objectives

- Explore what image processing is about
  - Image
    Display and Perception
    - Examples and Observations

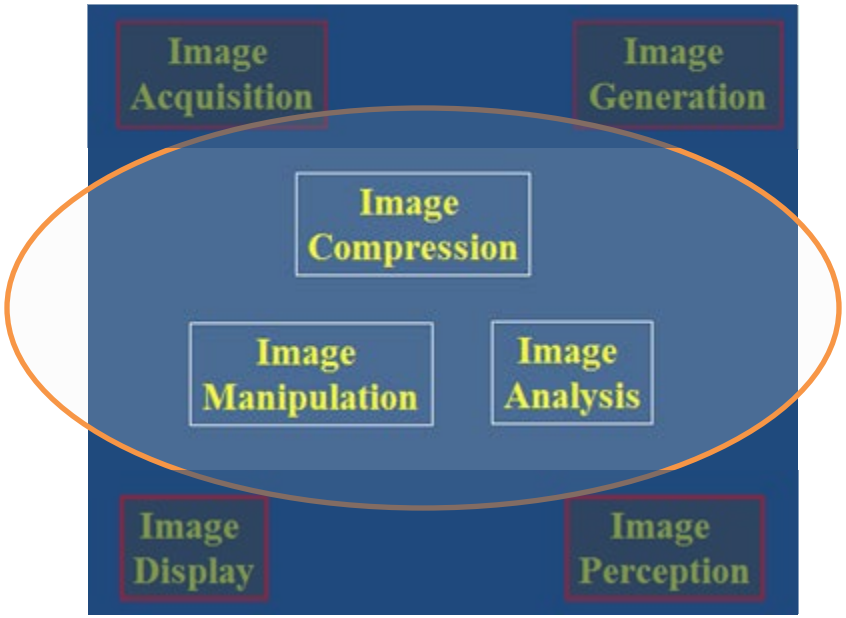
Lecture Objectives

- Explore what image processing is about
  - All relate to
    - Image Compression
    - Image Manipulation
    - Image Analysis



Digital Image Processing

- **Digital Image Processing (DIP)**
  - **Is *computer* manipulation of pictures, or images, that have been converted into numeric form**



Historical Background 1827

The first permanent image ever photographed.

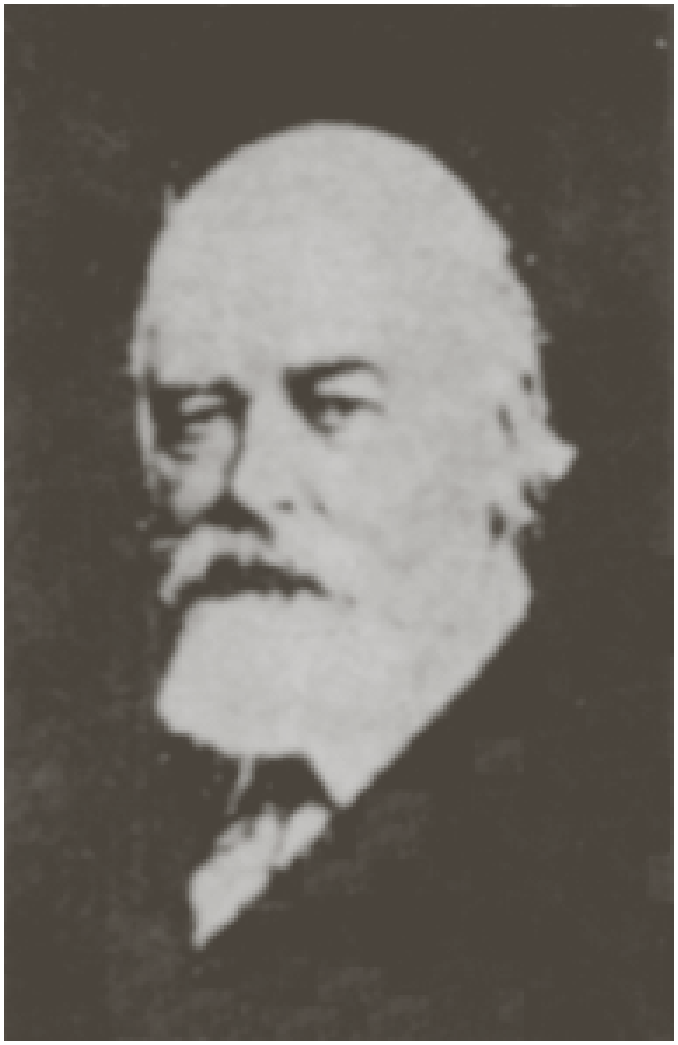
Joseph Nicephore Niepce. View from his window at Le Gras, 1827. Heliograph. Gernsheim Collection, Humanities Research Center, University of Texas, Austin

Historical Background 1921

- Image transmitted via Telegraph
  - using the Bartlane cable picture transmission system
  - Printed using a special printer rigged with typefaces simulating halftones

Historical Background 1922

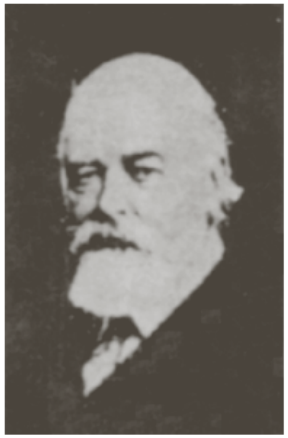
- Alternate printing method using tape perforations
  - improved tonal quality
  - improved resolution
- Still limited to 5 levels of grey



Historical Background – Late 1920s

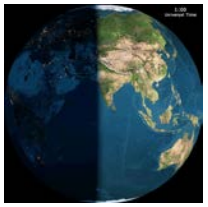
- Improved up to an amazing 15 levels of gray

No Computers



- These images were digital in nature
- BUT
  - did not involve computers
  - NOT Digital Image Processing

Good Stuff Gets Better



- Jumping over some decades of time, improvements made in:
  - Acquisition
    - Digital cameras, scanners
    - MRI and Ultrasound imaging
    - Infrared and Microwave imaging
  - Transmission
    - Internet, satellite, wireless
  - Storage
    - CD/DVD, Blu-ray
    - Flash memory, Phase-change memory
  - Display
    - GPUs
    - Printers, LCD and LED monitors and TVs
    - Portable DVD/Blu-ray players (cars), Tablets, Cellphones

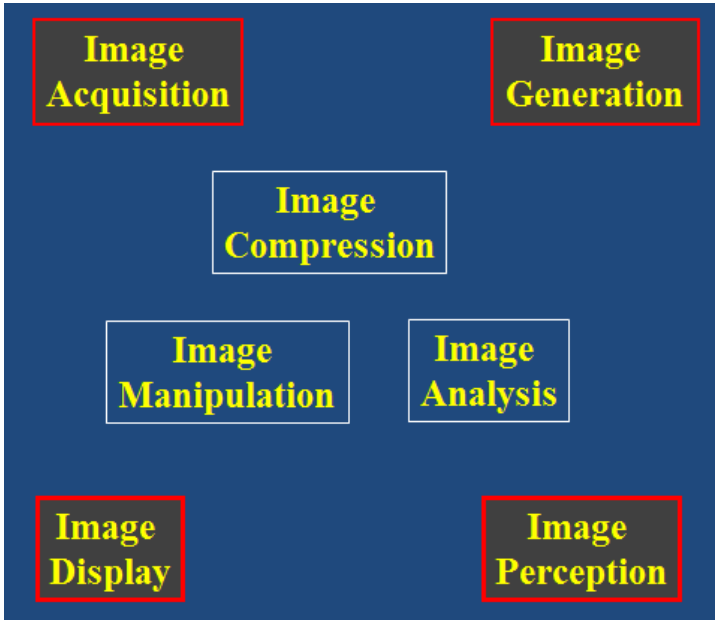


Image Processing History 1960-1970

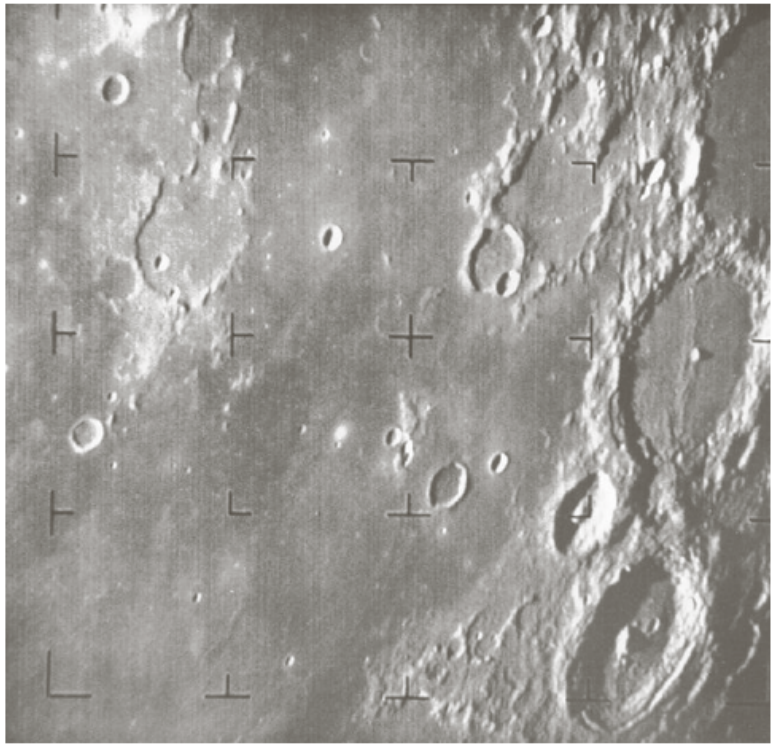


FIGURE 1.4 The first picture of the moon by a U.S. spacecraft. *Ranger 7* took this image on July 31, 1964 at 9 : 09 A.M. EDT, about 17 minutes before impacting the lunar surface. (Courtesy of NASA.)

- Ranger 7 Image
  - Digital with 256 gray levels
  - Geometric correction and image enhancement
    - Work conducted at the Jet Propulsion Laboratory (Pasadena, CA)

Image Processing History 1970-1980

- Emergence of medical imaging

- 1979 Nobel Peace Prize for Invention of Computerized Axial Tomography (CAT)
  - Sir Godfrey Housefield
  - Professor Allan Cormack

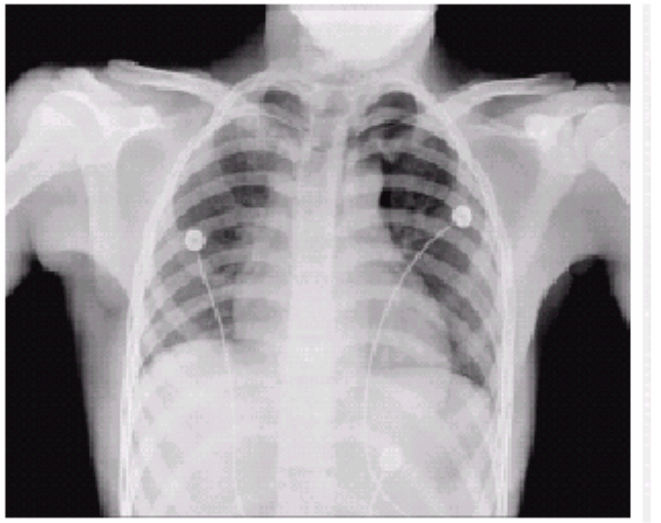


Image Processing History 1980-1990

- Satellite and Remote Sensing
  - LANDSAT
    - 8 spectral bands,
    - 15 to 60 meter spatial resolution,
    - 16 day temporal resolution
  - NOAA GEOS
    - satellite sensor array

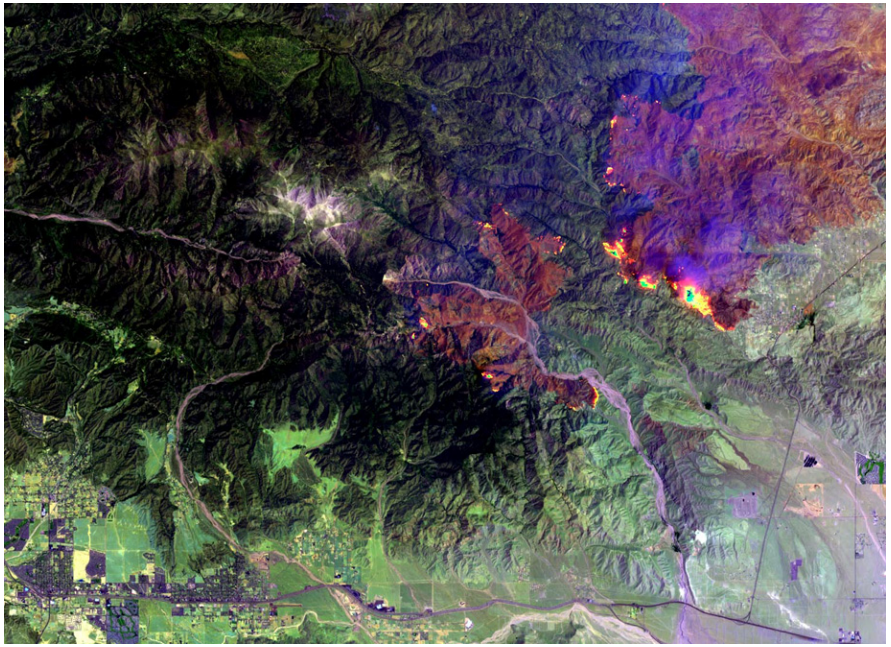
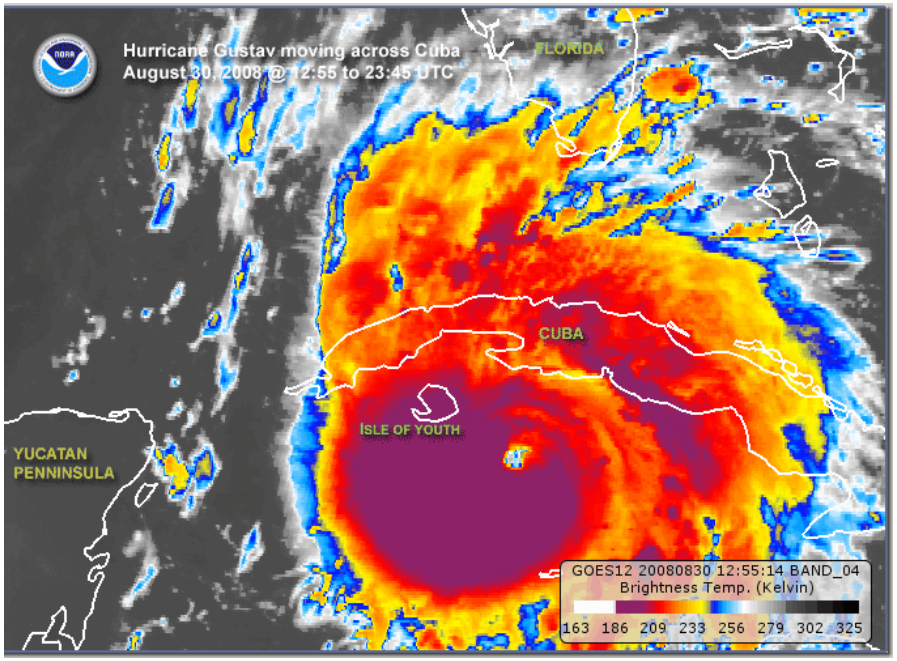


Image from 2009, courtesy of NASA
Fire San Bernardino National Forest



Multispectral image of Hurricane Gustav
courtesy of NOAA 2008

Image Processing History 1990-2000

- Morphing and visual effects algorithms
- JPEG and MPEG compression
- Wavelet Transforms

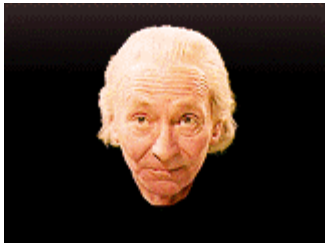


Image morph from Michael Jackson Music Video: Black or White

Dr. Who Image morphs antonybennison.com

Again: Digital Image Processing

- **Digital Image Processing (DIP)**
  - **Is *computer* manipulation of pictures, or images, that have been converted into numeric form**

  - Typical operations include
    - Image Compression
    - Image Warping
    - Contrast Enhancement
    - Blur Removal
    - Feature Extraction
    - Pattern Recognition

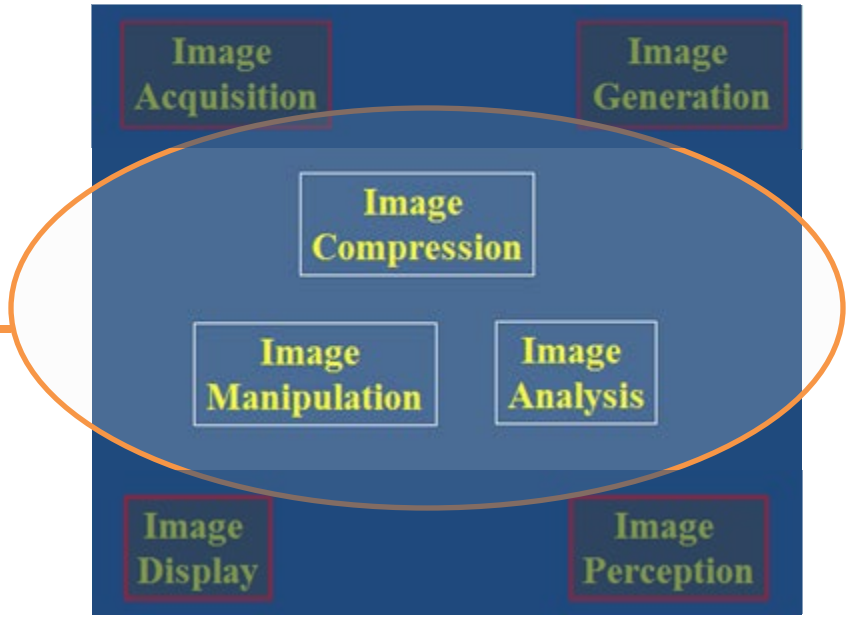


Image Processing **Goals**

- Digital image processing is a **subclass of signal processing specifically concerned with picture images**

  - Goals
    - To improve image quality for
      - human perception (subjective)
      - computer interpretation (objective)
    - Develop methods and applications
      - to compress images
      - to provide efficient storage and transmission

Related Fields

- Computer Graphics
- Computer Vision
- Artificial Intelligence
- … others…

Distinction Between Fields

- Image processing is **not just image-in/image-out**

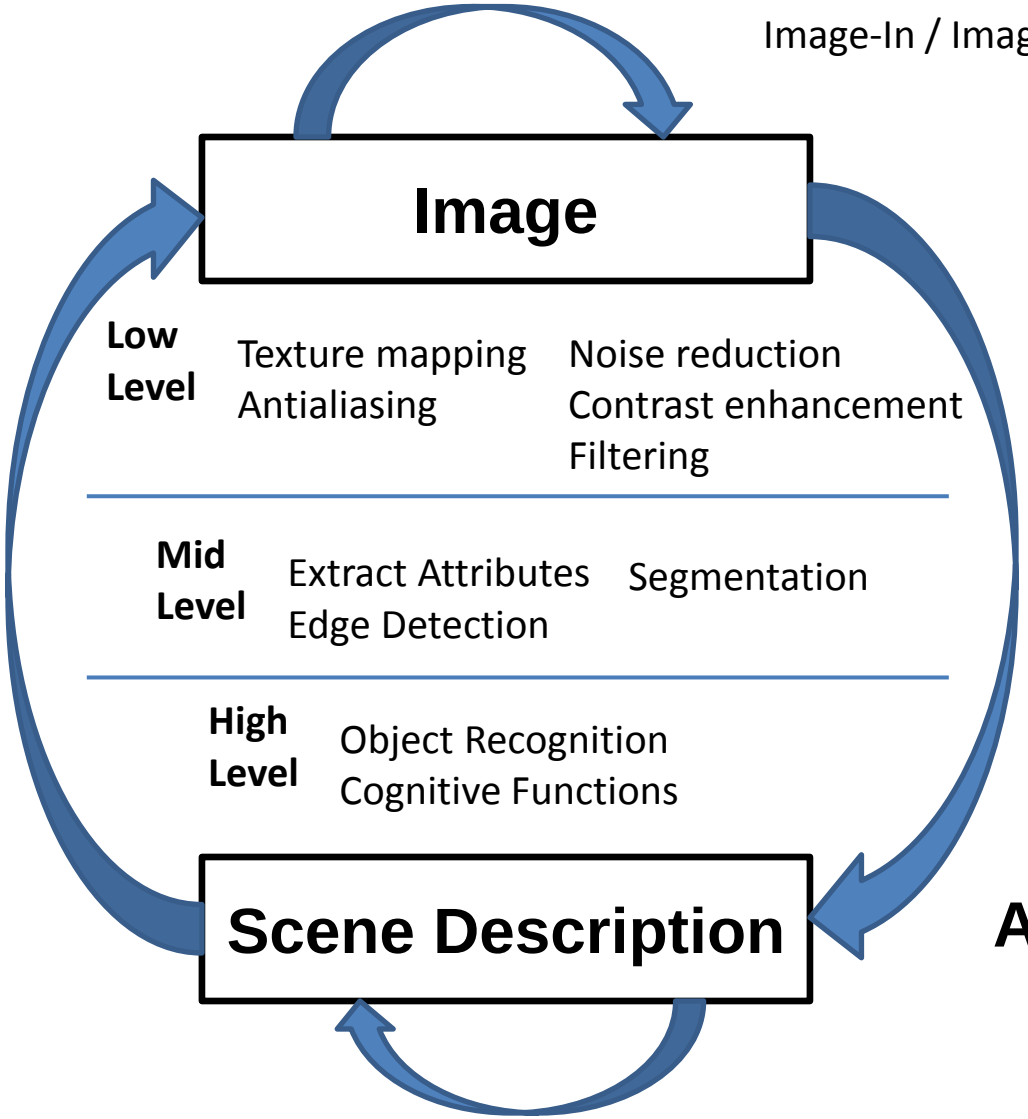
- **But it does work to distinguish relational aspects of some fields**

Input \ Output	**Image**	**Description**
Image	Image Processing	Computer Vision
Description	Computer Graphics	Artificial Intelligence

Related Fields

Image Processing

Image-In / Image Out



Computer Graphics

Description In
Image Out

Computer Vision

Image In
Features Out

AI

Features In
Description Out

Questions?

- Beyond D2L
  - Examples and information can be found online at:
    - *http://docdingle.com/teaching/cs.html*

    - *Continue to more stuff as needed*

Extra Reference Stuff Follows

Credits

- Much of the content derived/based on slides for use with the book:
  - *Digital Image Processing,* Gonzalez and Woods

- Some layout and presentation style derived/based on presentations by
  - Donald House, Texas A&M University, 1999
  - Bernd Girod, Stanford University, 2007
  - Shreekanth Mandayam, Rowan University, 2009
  - Igor Aizenberg, TAMUT, 2013
  - Xin Li, WVU, 2014
  - George Wolberg, City College of New York, 2015
  - Yao Wang and Zhu Liu, NYU-Poly, 2015
  - Sinisa Todorovic, Oregon State, 2015