Introduction

- An image is a 2-d function $f(x,y)$
  - $x$ & $y$ give location in 2-d image
  - Amplitude of $f(x,y)$ gives intensity or gray level
- When $f(x,y)$ is sampled, then it is a digital image
  - $x$ & $y$ are integers
  - Each sample called a pixel
- An image can be any 2-d intensity function
  - Any part the the electromagnetic spectrum
  - Sound waves
  - Electron beam

Introduction

- Image processing
  - Image in; image out
- Image analysis
  - Segmentation, description, classification
  - Image in; extracted attributes out
- Computer vision
  - Artificial intelligence

History

- 1920's Bartlane picture transmission system
- 1950-1970 digital computers
- 1970-1990 specialized image processing systems
- 1990-today image processing with main CPU in main memory

Gamma ray imaging

- Positron emission tomography (PET)
- Patient given a radioactive isotope that emits positrons
- Areas that absorb the most of the isotope are brightest
- Two tumors appear in image
X-ray imaging
- Computerized axial tomography (CAT)
- Data collected from many angles
- Image formed in computer using tomographic reconstruction
- Brightness indicates density

Ultraviolet imaging
- Based on phenomenon of fluorescence
- Healthy corn and smut corn shown at right

Visible & infrared bands
- Multi spectral image of hurricane Andrew

Visible light imaging
- Finding product defects using image analysis
- Imaging conditions can be controlled
Infrared imaging
- Shows distribution of human settlements
- Can also be used to find distribution of energy use

Microwave imaging
- Synthetic aperture radar (SAR)
- Can penetrate clouds, and sometimes ice, vegetation, dry sand
-Brightness a function of topographic effects, roughness, electrical properties, angle of incidence

Radio band imaging
- Magnetic resonance imaging (MRI)
- Another tomographic imaging technique
- Images distribution of hydrogen; water is primary source of hydrogen
- Used to image soft tissues

Other imaging modalities
- Sound waves – medical and geophysical applications
- Electron beams
  - Transmission electron microscope (TEM)
  - Scanning electron microscope (SEM)
- Artificially generated images
Course overview

- Digital image fundamentals
  - Perception
  - Acquisition
  - Sampling & quantization
- Image enhancement in the spatial domain
  - Point processing
  - Filtering with a mask or kernel
- Image enhancement in the frequency domain
  - Fourier transform theory
  - Filtering in frequency domain
- Image restoration
  - Degradation modeling
  - Inverse filtering
  - Wiener filtering

Course overview

- Color image processing
  - Color models
- Morphological image processing
  - Morphological operations
  - Morphological algorithms
- Image segmentation
  - Boundary detection
  - Region-based segmentation
- Representation & description
  - Boundary descriptors
  - Region descriptors
  - Pattern recognition

Course overview

- Image compression
  - Information theory
  - Error-free compression
  - Lossy compression