

Image Processing, Image Analysis, & Computer Vision

Team 5:

Matt Wesolowski, Joe McAuliffe, James Quaglia,
Ian Siekkinen, Petros Taskas, Poyuan Han

Anatomy of an Image

Types of Images:

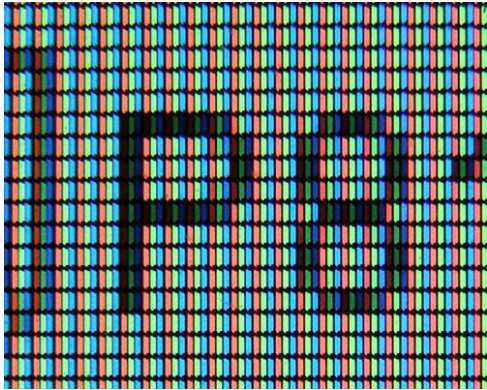
- Black and White (Binary Image) "2D" (1200x960x1)
- Grayscale "2D" (1200x960x1)
- RGB (Color Image) "3D" (1200x960x3)

The Pixel

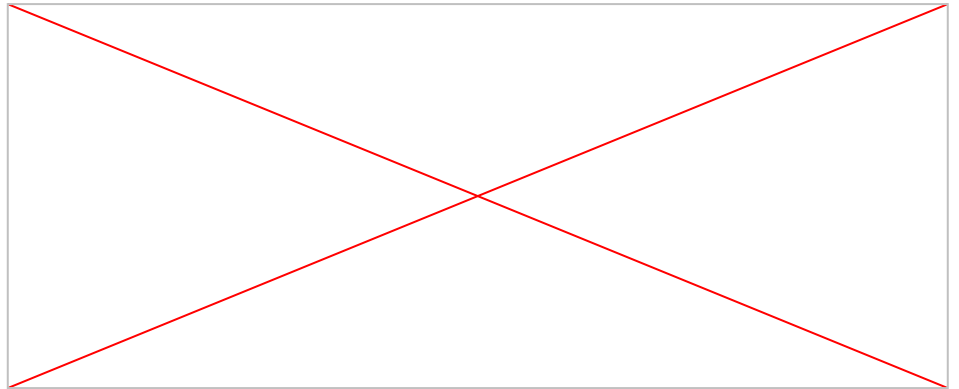
- In digital imaging, a **pixel**, is a physical point in a raster image
- Smallest addressable element in an all points addressable display device
- Smallest controllable element of a picture represented on the screen.
- The address of a pixel corresponds to its physical coordinates.
- LCD pixels are manufactured in a two-dimensional grid. Are often represented using dots or squares
- CRT pixels correspond to their timing mechanisms and sweep rates.

Pixels

LCD Pixel Grid



CRT Pixel Grid



The Pixel

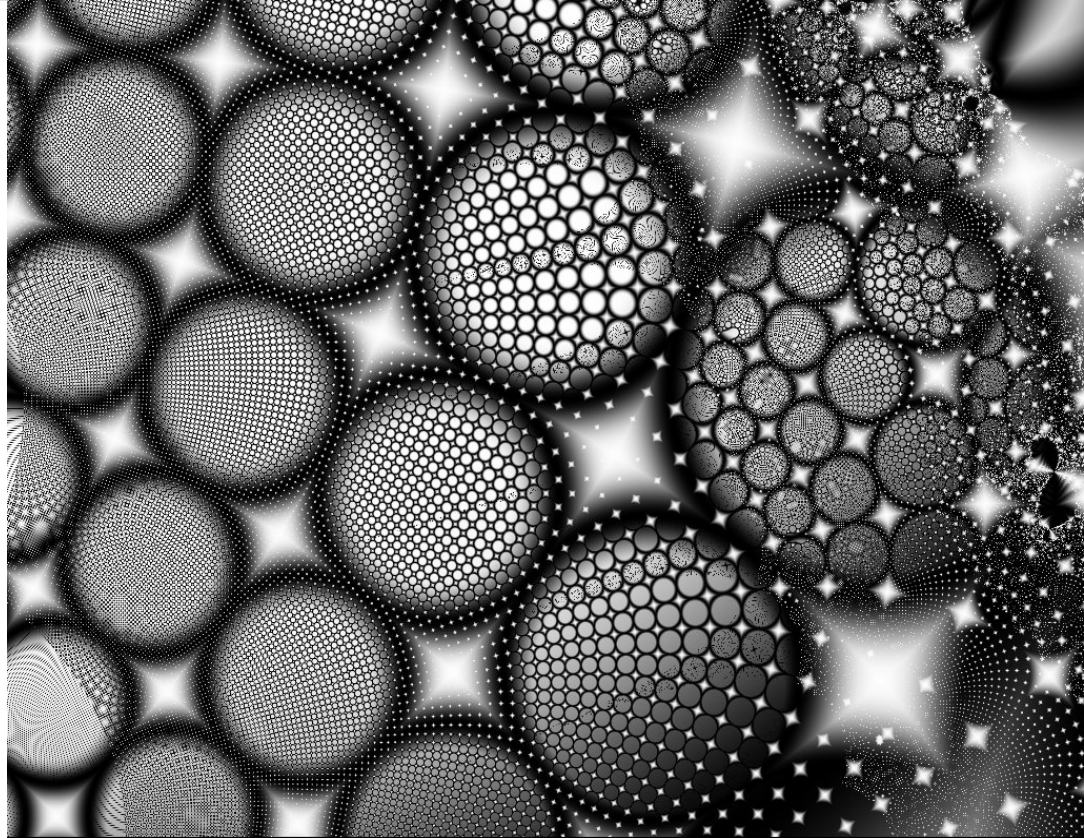
Bits per pixel

The number of distinct colors that can be represented by a pixel depends on the number of bits per pixel (bpp). A 1 bpp image uses 1-bit for each pixel, so each pixel can be either on or off. Each additional bit doubles the number of colors available, so a 2 bpp image can have 4 colors, and a 3 bpp image can have 8 colors:

- 1 bpp, $2^1 = 2$ colors (monochrome)
- 2 bpp, $2^2 = 4$ colors
- 3 bpp, $2^3 = 8$ colors
- ...
- 8 bpp, $2^8 = 256$ colors
- 16 bpp, $2^{16} = 65,536$ colors ("Highcolor")
- 24 bpp, $2^{24} = 16,777,216$ colors ("Truecolor")

Black and White (Binary Image)

- All pixels either black or white
- One layer deep
- 1 bpp



Grayscale Image

- Each pixel some value between black (0) and white (1); typically 8bpp
- With 8 bits, step size is 256 intermediate gray colors in between white and black
- Convenient because 1 pixel = 1 byte



RGB (Color Image)



RGB Color Image

The **RGB color model** is

an additive color model in which red, green, and blue light are added together in various ways to reproduce a broad array of colors.

Intensity levels of Red, Green, and Blue colors are chosen and overlaid to produce different colors



(213, 111, 56) - Digital 8-bit per channel notation

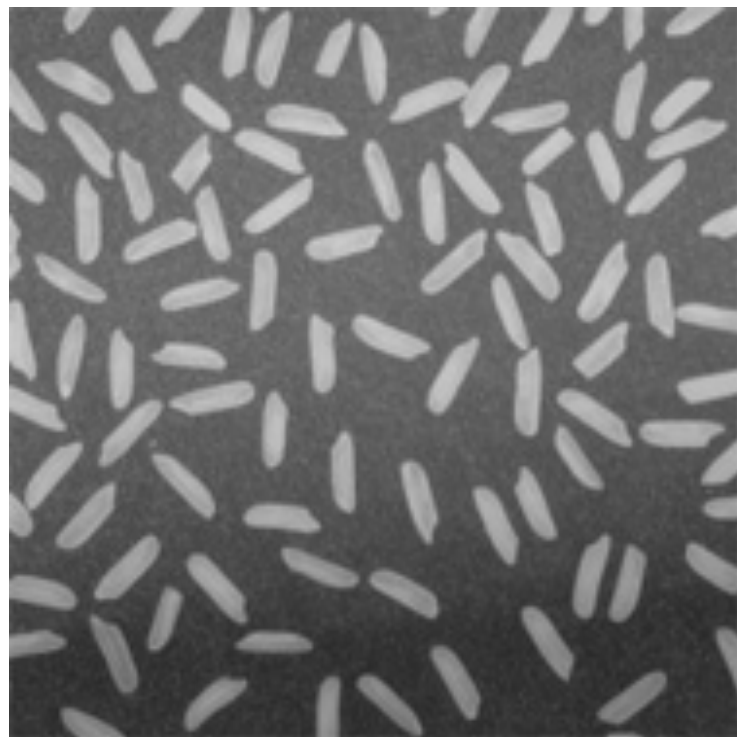
Notation	RGB triplet
Arithmetic	(1.0, 0.0, 0.0)
Percentage	(100%, 0%, 0%)
Digital 8-bit per channel	(255, 0, 0) or sometimes #FF0000 (hexadecimal)
Digital 16-bit per channel	(65535, 0, 0)

Image Enhancement

- Filtering
- Deblurring
- Noise Removal

What is a filter?

- A device that alters a digital image to achieve a desired result
 - Sharpen image
 - Remove noise
 - Brighten







Deblurring

Original Image (courtesy of MIT)

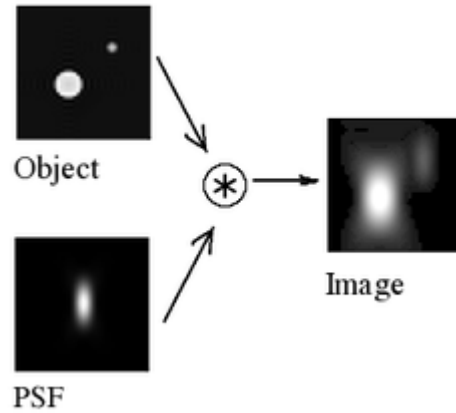


Blurred Image



Wiener Filter

- De-Convolve the image with PSF and NSR
- Image with only blurring NSR=0



Blurred Image



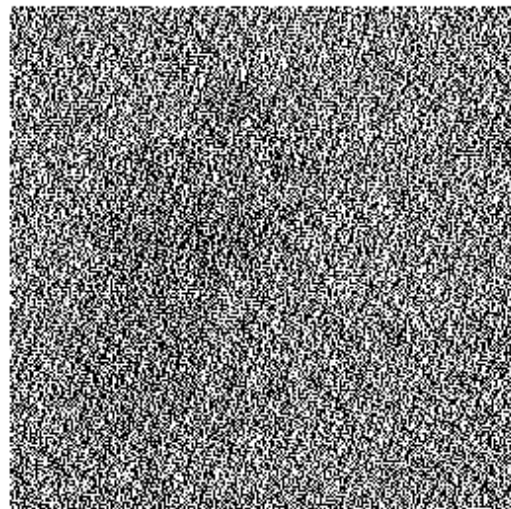
Restored Image



Simulate Blur and Noise



Restoration of Blurred, Noisy Image Using $NSR = 0$



- NSR not equal 0
- estimate noise level
 - known noise
 - experimental

Restoration of Blurred, Noisy Image Using Estimated NSR



Image Analysis

Image Segmentation

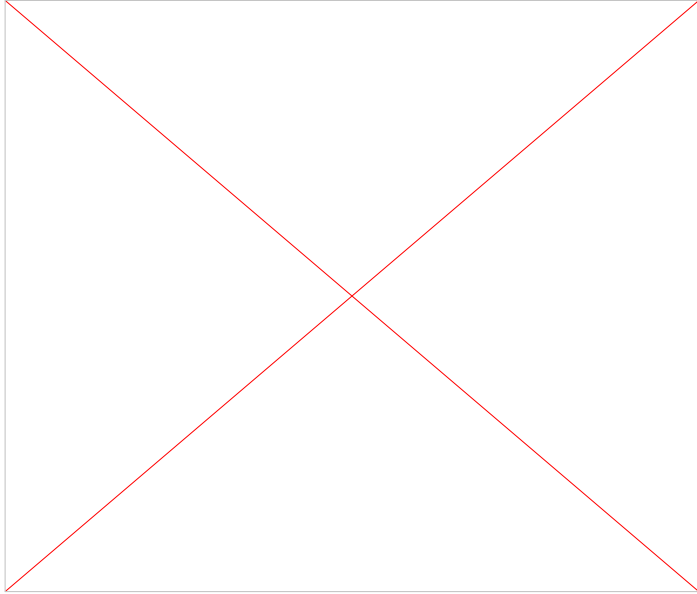
- Image Thresholding
- Color Based Image Segmentation
- Noise Filtering
- Edge Detection

Image Analysis

Measuring Image Features

- Counting the number of objects
- Identifying objects by type
- Measuring angles or distances

Image Analysis



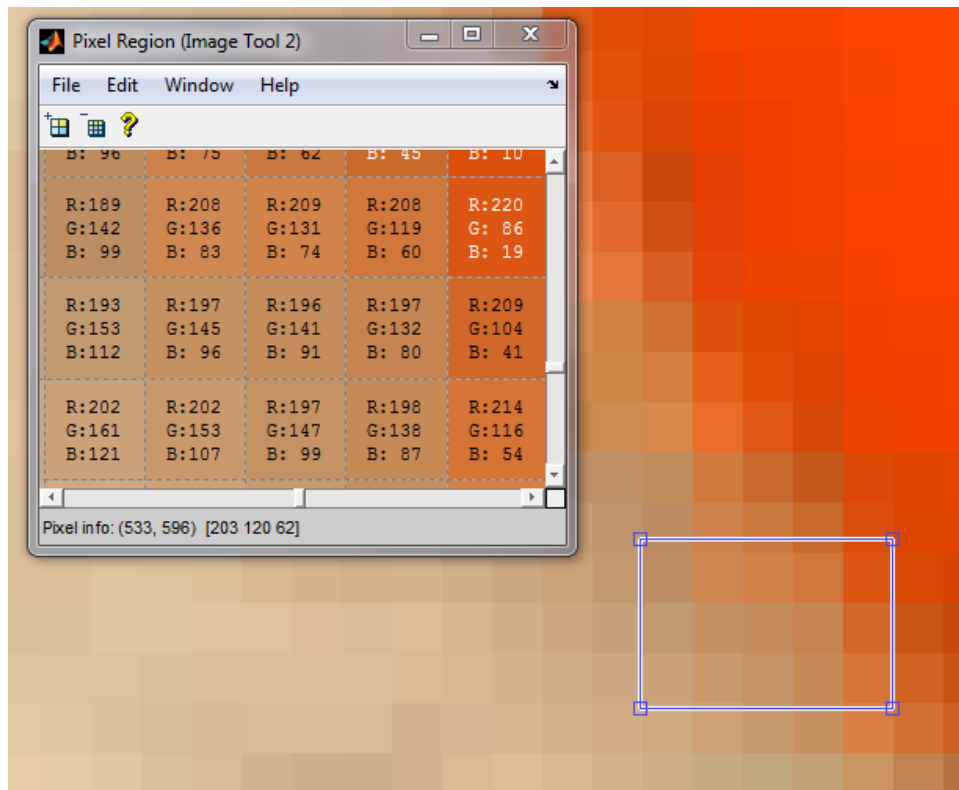
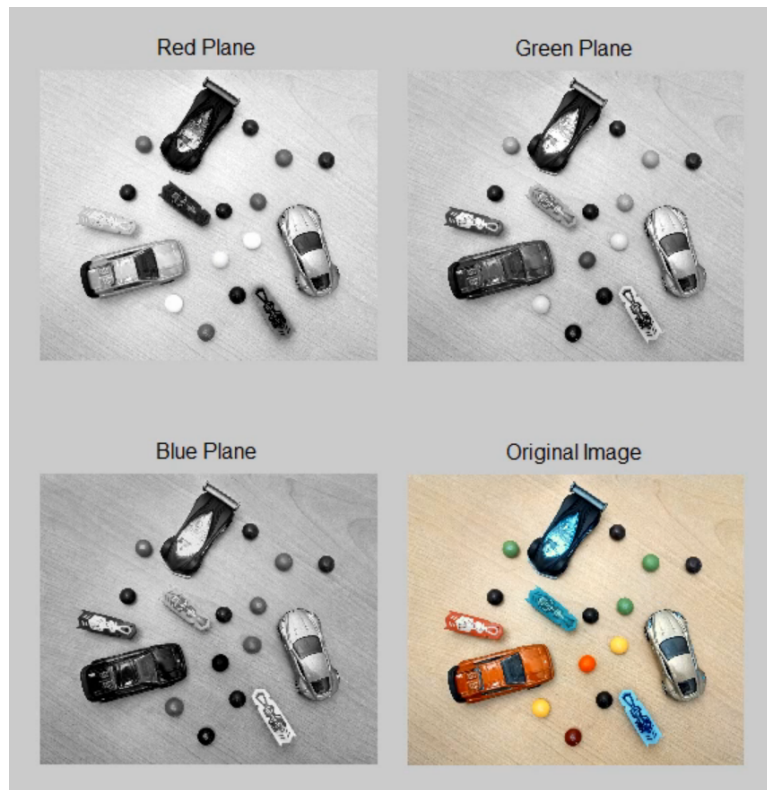
rgb2gray

Image Thresholding

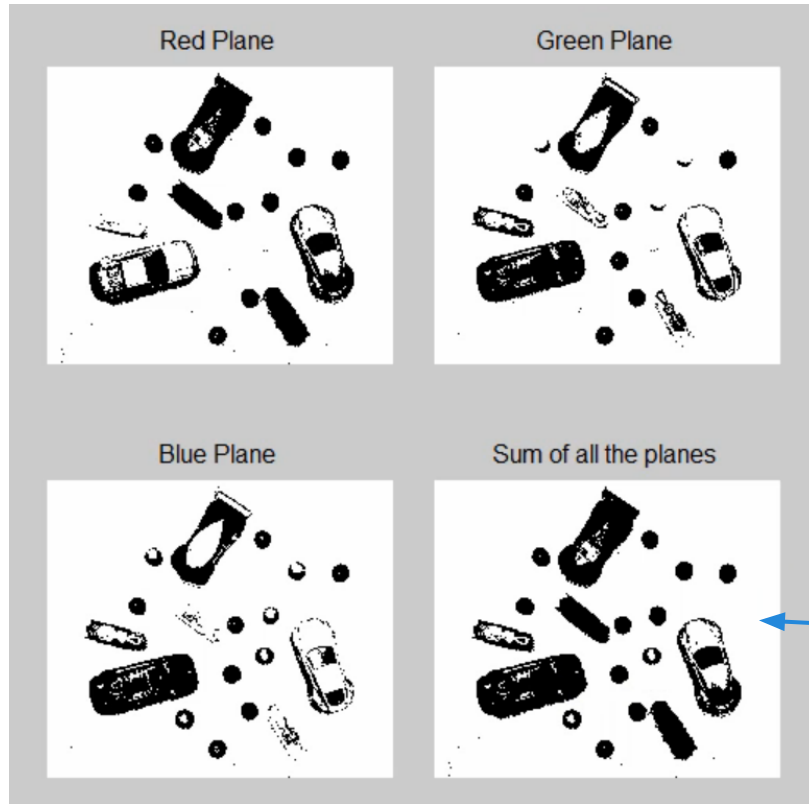


im2bw - Thresholding increased

Color Based Image Segmentation



Color Based Image Segmentation



Before &
After



Using Morphological Functions to

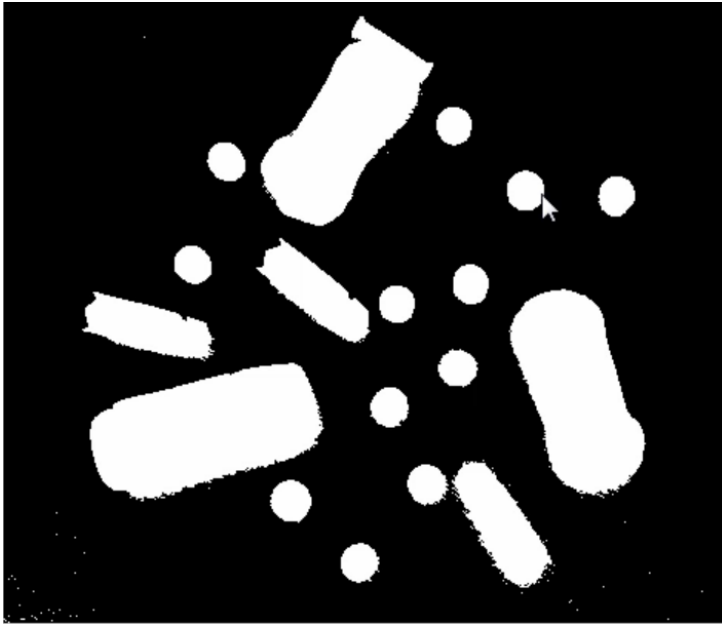
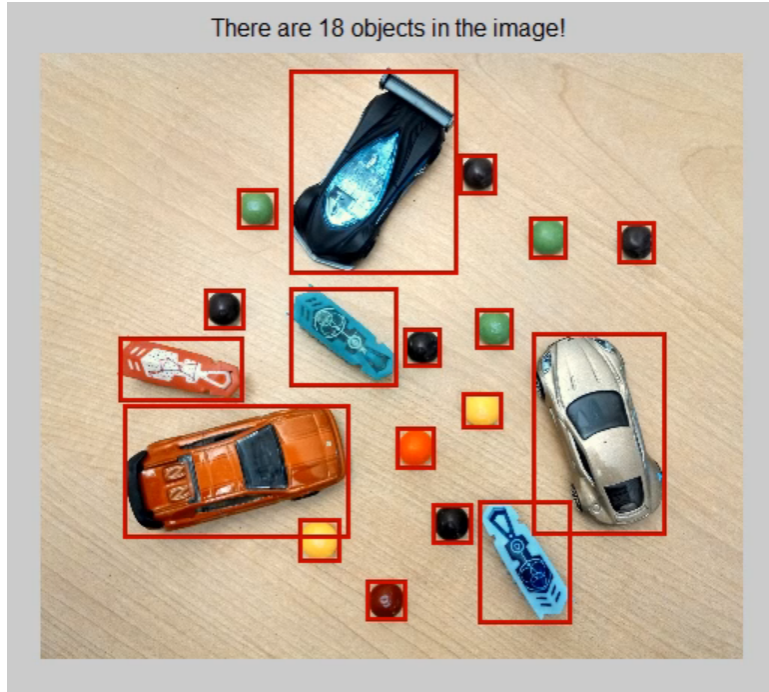


Image Segmentation - Final



- Number of objects/blobs identified & counted
- Bbox added

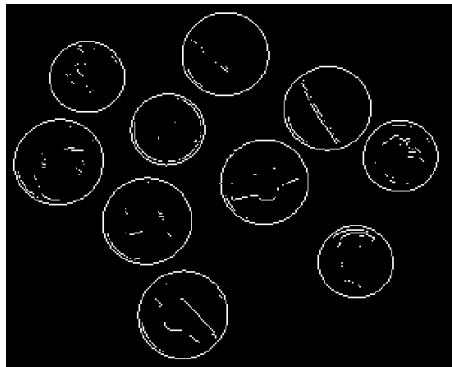
Edge Detection



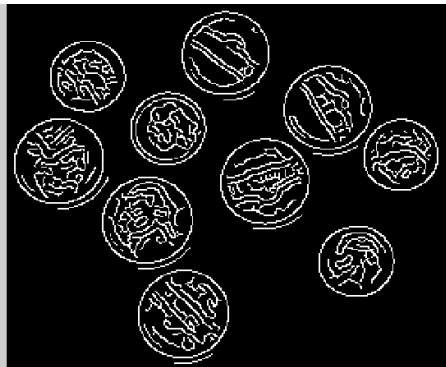
Methods

- Sobel
- Canny
- Wes

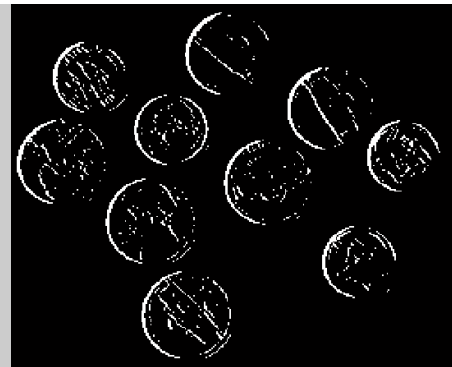
Edge Detection



Sobel

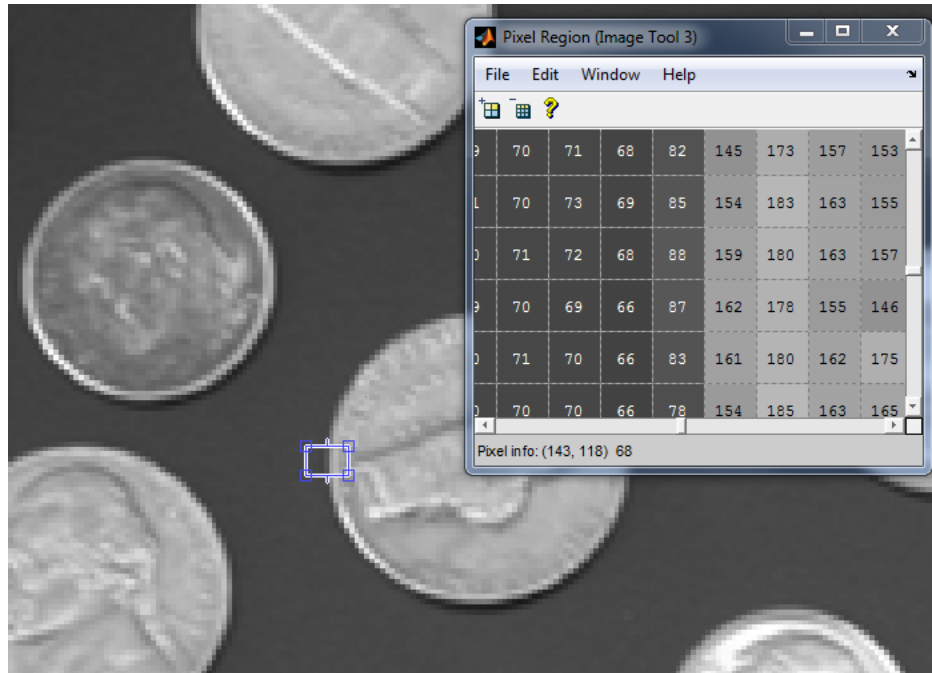


Canny



Wes

Edge Detection



1	-3	14	63	28	-6	-4
3	-4	16	69	29	-20	-8
1	-4	20	71	21	-17	-6
-1	-3	21	75	16	-23	-9
-1	-4	17	78	19	-18	13
0	-4	12	76	31	-22	2

Change in
intensity to
the right

Measuring Image Features

▼ Measuring Image Features



Detect and Measure Circular Objects in an Image

 Script



Finding the Length of a Pendulum in Motion

 Script



Granulometry of Snowflakes

 Script



Identifying Round Objects

 Script



Measuring Angle of Intersection

 Script



Measuring Regions in Grayscale Images

 Script



Measuring the Radius of a Roll of Tape

 Script

Object Detection

The process of finding instances of real-world objects through media including:

- People
- Bicycles
- Buildings
- Cars
- Misc. Objects

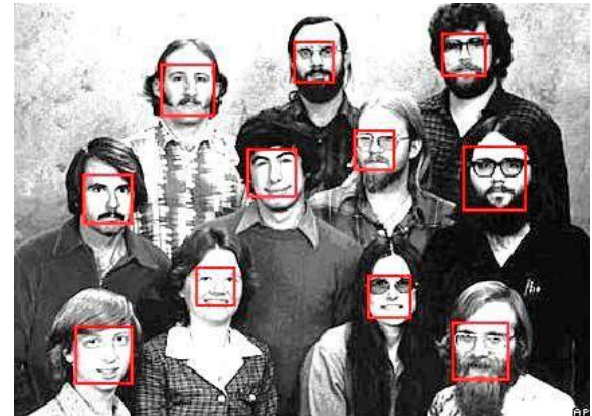
Face Detection

Computer algorithms use extracted features from the faces being recorded using color and orientation

Ignores all other objects within frame

Uses:

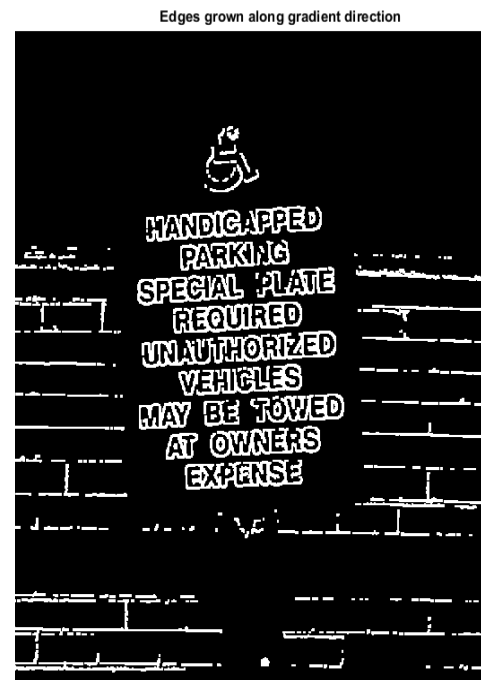
- Image Retrieval
- Security
- Surveillance



Text Detection

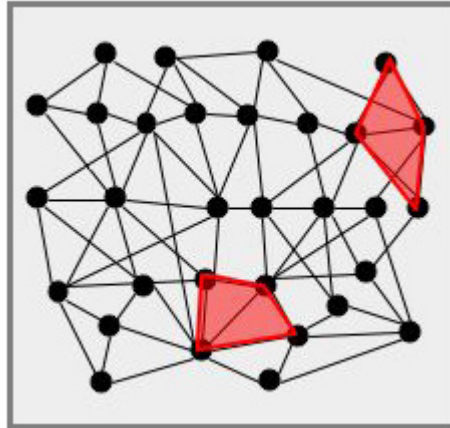
Done easily since text is usually displayed on plain backgrounds

There is a great difference in adjacent pixel contrast



Pattern Matching

- Act of checking a given sequence of edges in one local region/image to another
- The match must be exact



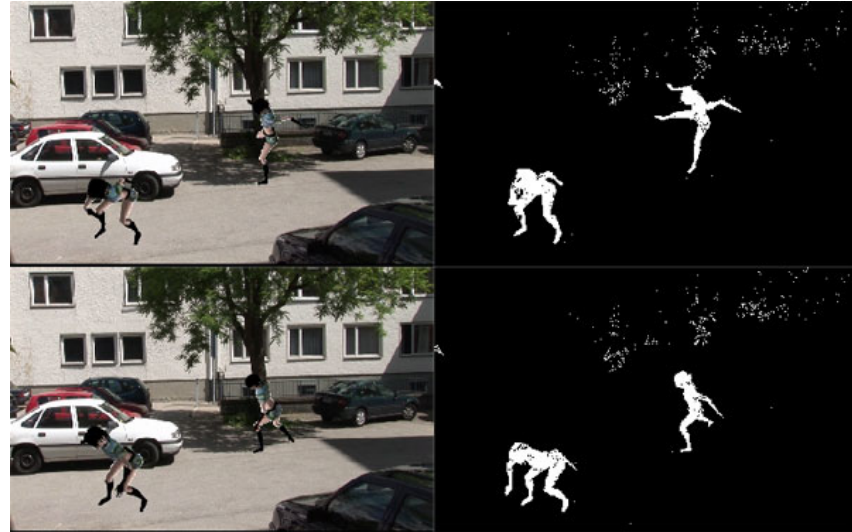
Object Tracking

- Process of locating a moving object in time using a camera
- Detects object in each frame
- Associates each new frame to the previous one
 - Compares difference in object movements through each frame

Background Subtraction

Compares a still videos
current frame to a
reference frame

Used in surveillance and
human tracking

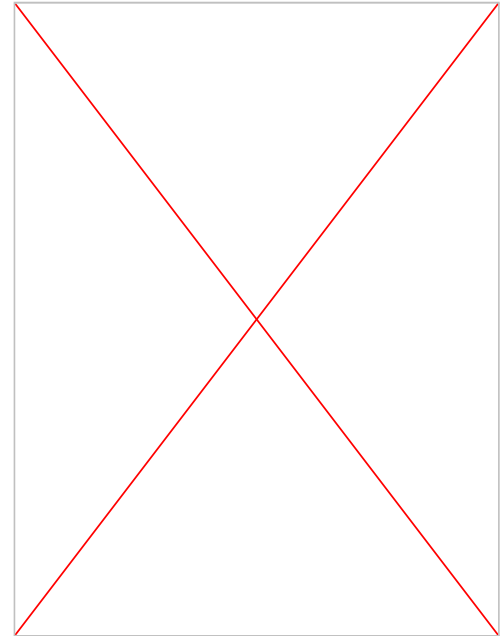


Applications

- Medical
- Smart Camera
- Geospatial Computing

Medical

MRI: Use magnetic field and radio wave pulse from a MRI scanner and produces image



Smart Camera

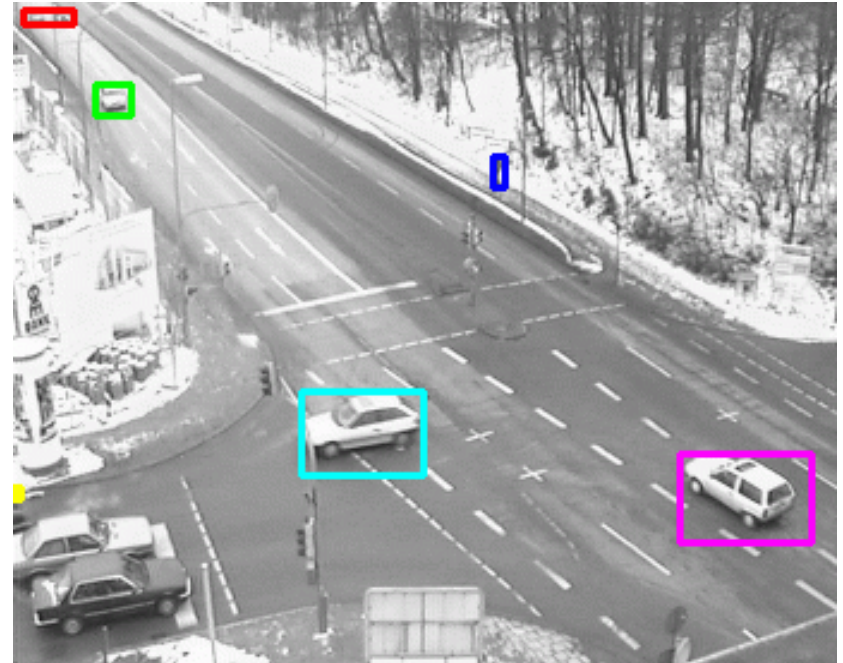
Use pixel edge detection to measure objects

- Traffic
- Faces
- Military



Traffic Surveillance

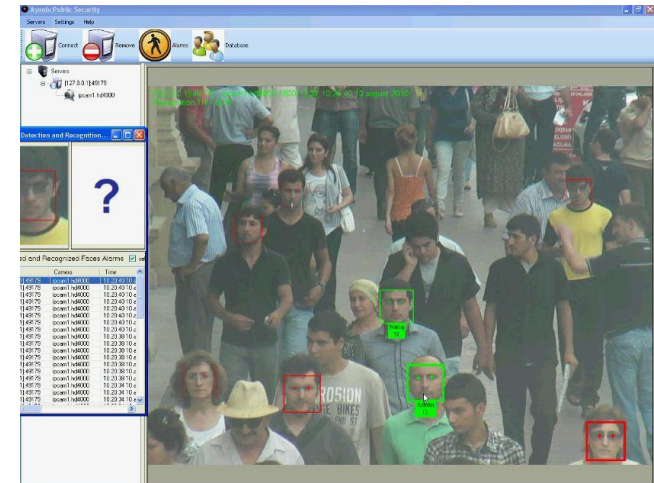
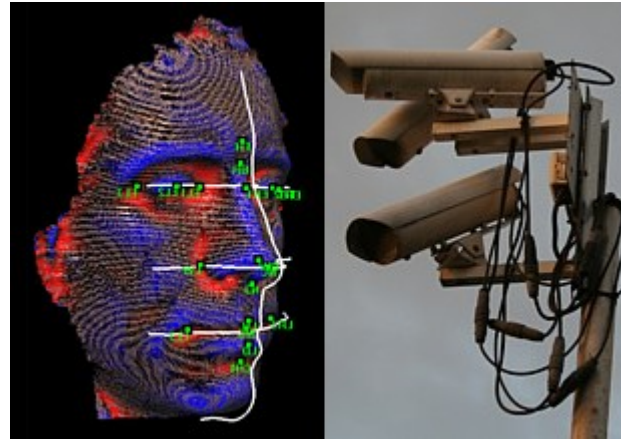
- Aid Commuter
- Valuable data
- Enforce law



Facial Recognition

Technique:

- 3D recognition
- Skin texture analyze

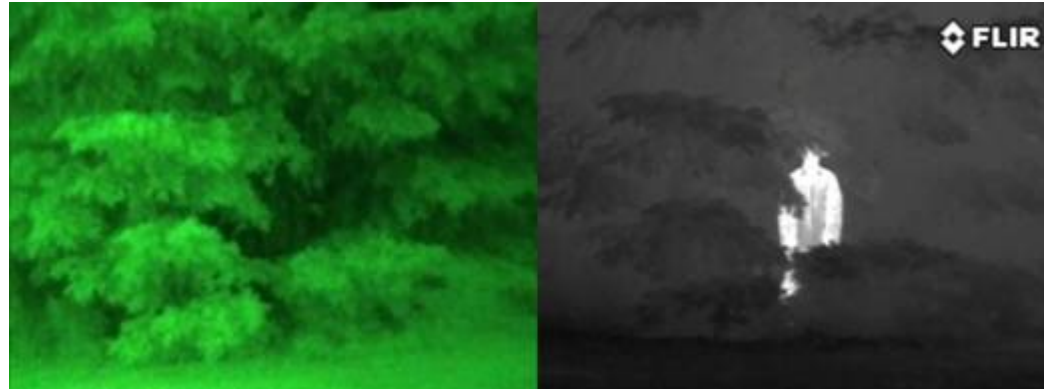


Military

Thermal Camera- A device that forms image by infrared radiation



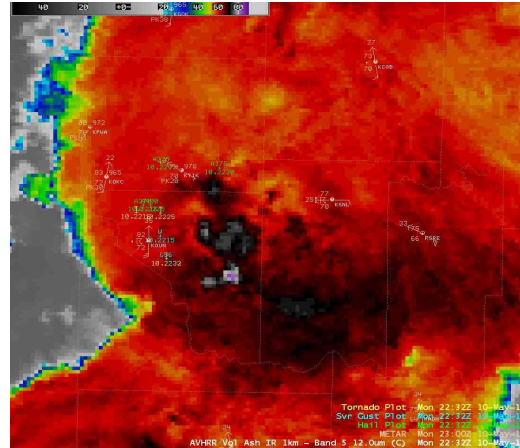
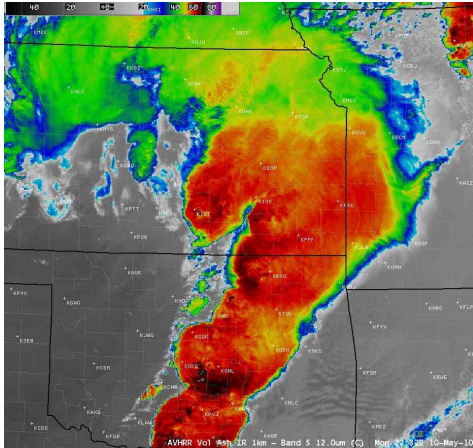
- Weight Under 3.75 lbs
- Latest 8-12 μm Uncooled Detector Technology
- Digital Magnetic Compass
- Cross Hair & Mil-Dot Reticle Selection
- AA Battery & External Power
- Rugged, Reliable Performance
- Shock Protected Precision Optics
- 2 Field of View (FOV)



Geospatial computing

GIS- Geographic Information System

- Image Registration - Overlays two different images using similar features



Questions?