2A - L1 images as functions

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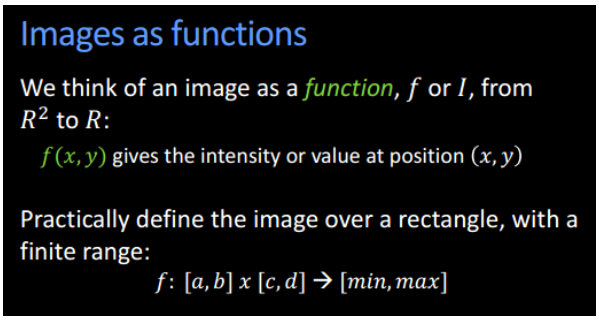
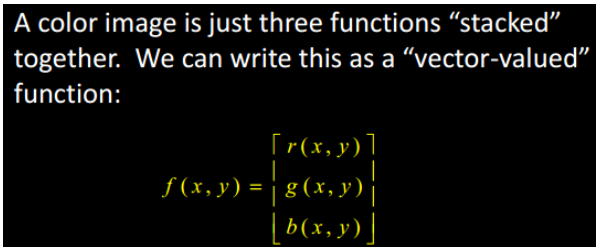
- Sum
  - one image is a function
  - manipulation of the image through the matrix
    - add, multiply, subtract, blend, crop
  - display the image
    - imshow, plot
  - Octave/matlab functions
    - imread, imshow, hist,
  - noise
    - Gaussian noise
    - sigma
- 2. Images as Functions - mathematical view
  - One image can be regarded as a function. I(x, y), the value of the light intensity
    - can be shown in matlab
    - function - grey scaled
      - mapping: R x R → R
      - f: [a, b] x [c, d] → [min, max]
      - each (x,y) corresponding to a value i



  - function - colored
    - mapping: R x R → R x R x R
    - f: [a, b] x [c, d] → [min, max] x [min, max] x [min, max]
    - each (x,y) corresponding to a vector (r, g, b)
    - each channel can be taken out alone as a r/g/b plane to be processed



- #we do in grey scale images, it's easier cuz it only has one channel
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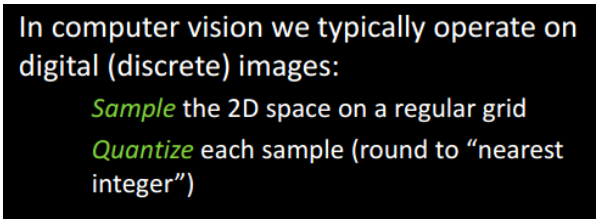
- 8. Digital Images
  - It's the discrete-valued image. so we require two discretions: Sample and Quantize
    - ATT: when computing, regard the value as floating point
    - # pixel : an image element



  - Image thus represented as a **matrix** of integer values.
    - matlab typically with interger values
    - index
      - x, y used in math, x is along the column, y is along the row
      - i, j used in computation, i is along the row, j is along the column
    - 1 D signals are just represented as vectors
- 9. Quiz: Compute Image Size Quiz
  - image size = #row x #column x #channel #value size
- 10. Matlab Images are Matrices
  - Matlab Images are Matrices, (r, c, rgb), so that you can manipulate them as matrices.
- 12. Load and Display an Image
  - imread('xx.xxx')
- 14. Quiz: Image Size and Data Type Quiz
  - size
    - size()

- class type
  - e.g. uint8
    - u: unsigned means only non-negative value
    - int: integer
    - 8: 8 bits, 1 byte
    -

- 15. Inspect Image Values
  - as to access matrix
    - but to show a row/column, better to use plot(img(1,:))
- 18. Crop an Image
  - to take a big part of the image
  - for index, both the start and end row/column are included
- 21. Color Planes
  - im images, bright area represents higher values, while dark area represents lower values.
- 23. Add 2 Images Demo
  - img [0, 255], when the value exceeds, round to 255;
  - Octave rounds the value to the nearest integer for uint8, 1.5 => 2
  - add
  - average: /2 => +; not + => /2
- 25. Multiply by a Scalar Demo
- 26. Quiz: Blend 2 Images
  - Rule: keep the sum of the weights equal to 1; the bigger the weight, the more the effect of this image.
- 27. Common Types of Noise
  - η(x,y)
  - salt and pepper noise: random occurrences of black and white pixels
  - Impulse noise: random occurrences of white pixels
  - Gaussian noise -- most common
    - variations in intensity drawn from a Gaussian normal distribution
    - rand(size(img)) .* sigma
      - zero mean, sigma standard deviation
    - imgnew = img + noise
- 28. Image Difference Demo
  - directly substract may lose some values, since unit8 is [0,255];
  - so use imabsdiff(a,b) - order doesn't matter

- 30. Generate Gaussian Noise
  - e.g.
    - noise = randn(1,10000);
    - noise2 = noise .* 2;
    - std(noise)
    - % noise2 has doubled standard deviation of noise
    - because the GD represents the distribution the number of values in certain bin rather than the values themselves.
  - when add the noise to certain signal, what should be the concern is the noise magnitude compared to image magnitude. that's the effect of the sigma
- 35. Displaying Images in Matlab
  - determine how to show the image
    - imshow(im)
      - original range
    - imshow(im, [low, high])
      - rescaled, low represents the darkest black, high represents the whitest white
    - imshow(im, [])
      - rescaled, low is the min, high is the max in the original image
  - ATT
    - only the display may require rescale, never the computation