Image Processing and Computer Vision

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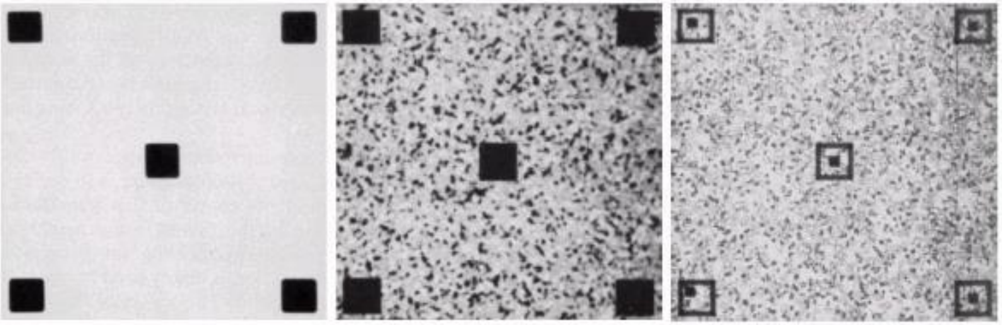
Local Enhancement

- **LOCAL HISTOGRAM EQUALISATION**
- In earlier methods pixels were modified by a transformation function based on the gray level of an entire image.
- It is not suitable when enhancement is to be done in some small areas of the image.
- This problem can be solved by local enhancement where a transformation function is applied only in the neighborhood of pixels in the interested region.
- Define square or rectangular neighborhood (mask) and move the center from pixel to pixel.
- For each neighborhood

  1. Calculate histogram of the points in the neighborhood
  2. Obtain histogram equalization/specification function
  3. Map gray level of pixel centered in neighborhood
  4. The center of the neighborhood region is then moved to an adjacent pixel location and the procedure is repeated.



ENHANCEMENT USING ARITHMETIC/ LOGIC OPERATION

- These operations are performed on a pixel by basis between two or more images excluding
- not operation which is performed on a single image.
- It depends on the hardware and/or software that the actual mechanism of implementation
- should be sequential, parallel or simultaneous.
- Logic operations are also generally operated on a pixel by pixel basis.
- Only AND, OR and NOT logical operators are functionally complete.
- Because all other operators can be implemented by using these operators.

ENHANCEMENT USING ARITHMETIC/ LOGIC OPERATION

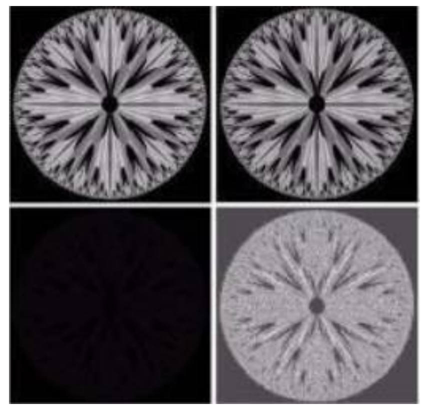
- While applying the operations on gray scale images, pixel values are processed as strings
- of binary numbers.
- The NOT logic operation performs the same function as the negative transformation.
- Image Masking is also referred to as region of Interest (RoI) processing.
- This is done to highlight a particular area and to differentiate it from the rest of the image.
- Out of the four arithmetic operations, subtraction and addition are the most useful for image
- enhancement.

Image Subtraction

- The difference between two images f(x,y) and h(x,y) is expressed as
- $g(x,y)= f(x,y)-h(x,y)$
- It is obtained by computing the difference between all pairs of corresponding pixels from f and h.
- The key usefulness of subtraction is the enhancement of difference between images.
- This concept is used in another gray scale transformation for enhancement known as bit plane slicing.
- The higher order bit planes of an image carry a significant amount of visually relevant detail while the lower planes contribute to fine details.
- It we subtract the four least significant bit planes from the image

Image Subtraction

- The result will be nearly identical but there will be a slight drop in the overall contrast due to less variability in the gray level values of image .



- The use of image subtraction is seen in medical imaging area named as mask mode radiography.
- The mask h (x,y) is an X-ray image of a region of a patient's body this image is captured by using as intensified TV camera located opposite to the x-ray machine then a consistent medium is injected into the patient's blood storm and then a series of image are taken of the region same as h(x,y).

Image Subtraction

- The mask is then subtracted from the series of incoming image.
- This subtraction will give the area which will be the difference between f(x,y) and h(x,y) this difference will be given as enhanced detail in the output image.

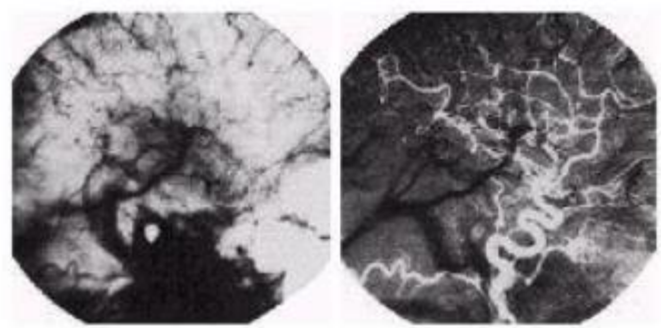


Image Averaging

- Consider a noisy image g(x,y) formed by the addition of noise n(x,y) to the original image f(x,y)

$$g(x,y) = f(x,y) + n(x,y)$$

- Assuming that at every point of coordinate (x,y) the noise is uncorrelated and has zero average value
- The objective of image averaging is to reduce the noise content by adding a set of noise images,

$$\{gi(x,y)\}$$

- If in image formed by image averaging K different noisy images

$$\overline{g}(x,y) = \frac{1}{K}\sum_{i=1}^{K} g_i(x,y)$$

$$E\{\overline{g}(x,y)\} = f(x,y)$$

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Image Averaging

- As k increases the variability (noise) of the pixel value at each location (x,y) decreases.
- $E\{g(x,y)\} = f(x,y)$ means that g(x,y) approaches f(x,y) as the number of noisy image used in the averaging processes increases.
- mage averaging is important in various applications such as in the field of astronomy where the images are low light levels.

Summary

- Spatial domain refers to the image plane itself.

- The three basic types of functions used frequently for image enhancement:

  1. Linear Functions:
  Identity Transformation
  Negative Transformation
  Contrast Stretching
  Thresholding
  2. Logarithmic Functions:
  Log Transformation
  Inverse-log Transformation
  3. Power-Law Functions:
  nth power transformation
  nth root transformation

- The negative of a digital image is obtained by the transformation function:

$$s = T(r) = L - 1 - r$$

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Summary

- The log transformations can be defined by this formula:

$$s = c \log(r + 1).$$

- Power-law transformations have the basic form of:

$$s = c.r^{\gamma}$$

- Types of Piecewise transformations are:
  - Contrast Stretching
  - Gray-level Slicing
  - Bit-plane slicing
- Contrast enhancements improve the perceptibility of objects in the scene by enhancing the brightness difference between objects and their backgrounds.
- Thresholding provides a way to perform this segmentation on the basis of the different intensities or colors in the foreground and background regions of an image.
- Gray level slicing is the technique used to highlight a specific range of gray levels in a given image.

Summary

- The image is composed of 8 1-bit planes.
- Plane 0 contains the least significant bit and plane 7 contains the most significant bit.
- Only the higher order bits (top four) contain visually significant data.
- In an image histogram, the x axis shows the gray level intensities and the y axis shows the
- frequency of these intensities.
- Histogram equalization is a common technique for enhancing the appearance of images.
- Equalization automatically determines a transformation function that seeks to produce an
- output image that has a uniform histogram.
- The difference between two images f(x,y) and h(x,y) is expressed as

$$g(x,y)= f(x,y)-h(x,y)$$

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