Introduction

- There are times we want to “improve” the quality of an image
  - Subjective improvement (“looks better”)
  - Emphasize important information
  - Removing/weakening noise

- Some of the approaches:
  - Histogram Equalization
  - Image Filtering
  - Other approaches:
    - Basic Intensity Transformations
    - Image Subtraction
    - N-Images Averaging
Histogram Equalization

- **Procedure:**
  - Compute histogram of image
  - Normalize histogram (divide by total number of pixels)
  - Get Cumulative Distribution Function (CDF) of histogram
    
    \[
    s = T(r) = CDF(r) = \frac{(L-1)}{N} \sum_{j=0}^{r} n_j
    \]
  - Use CDF (multiplied by 255) to reassign pixel values
    - \( s = T(r) = 255 \times CDF(r) \)

- **Problem:**
  - If first value (\( r = 0 \)) dominates histogram \( \rightarrow \) image washed out after equalization!
Histogram Stretching

- To fix this, we need to stretch out the values
  - Get the value of CDF[0] and subtract it from every value
  - Get value of CDF[255] and divide all values by CDF[255]
  - Then, perform remapping
Resulting Image after Histogram Equalization and Stretching
Image Filtering

- One can use image filters to:

  - Blur an image (15x15 Gaussian)
  - Sharpen an image (Laplacian)
  - “Enhance” an image (7x7 Median)
Other Image Enhancement Approaches

- **Intensity Transformations**
  - E.g., log transform

- **Image Subtraction**

- **N-Images Averaging**
  - Get average of multiple images to filter out noise