1. Image Enhancement

The aim of enhancement to better appearance , noise removal and facilitates processing steps
Image enhancement techniques can be divided into two categories :

- Spatial domain methods : which operate directly on pixels.
- Frequency domain methods: which operate on the fourier transform of an image.
  Image enhancement Classification/application:
- Pixel based / Point based
  - Only deals with the point or pixel
- Region based
  - Deals with the neighbors of the pixel in the region
- Global entire Image
  - Deals with the whole image

Image negative

Reproduces the bright parts of image as dark and the dark part as light areas

- $f'(x,y)_{negativeimage} = (L-1) - f(x,y)_{originalimage}$
- $L_{(graylevel)} = 2^q (q = No.\ of\ bits.\ if\ q = 8,\ then\ L = 2^8 = 256)$
- Negative simple program

```
for i=0, i<N, i++:
        for j=0, j<M, j++:
                fe(i,j) = (L-1)-f(i,j)
        end; //j
end; //i
```

Contrast stretching and contraction

Contrast stretching / histogram stretching

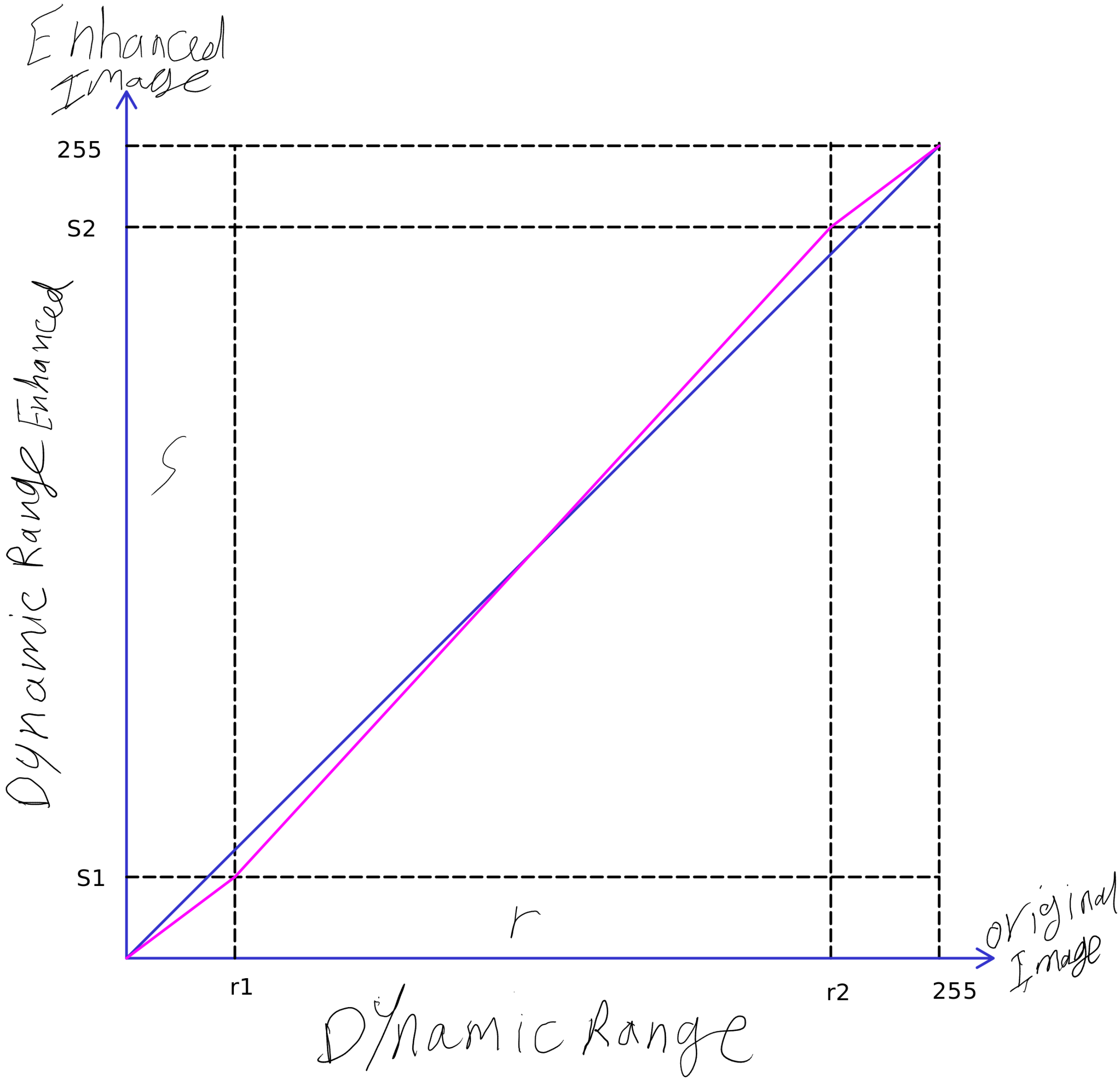
- There are two methods of enhancing contrast
  - histogram stretching that increase contrast
  - histogram equalization
  #note Stretching mean improve or increase contrast

Contrast contraction

- Algorithm that can solve the problem of objects are seen as multi-agents due to difference in gray value

Dynamic Range Stretching

The Dynamic Range : it is the range in which the image details exist.
#note So the focus is to increase the range with contracting dark towards darker and white towards whiter.



r1 > S1 & r2 < S2

- First line: 0 --> r1

$$f'(x,y) = f(x,y)\frac{S1}{r1}$$

- Second line r1 --> r2

$$f'(x,y) = f(x,y)\frac{S2 - s1}{r2 - r1} + S1 - r1\frac{S2 - s1}{r2 - r1}$$

- Third line r2 --> 255

$$f'(x,y) = f(x,y)\frac{(L-1) - s2}{(L-1) - r2} + (L-1) - (L-1)\frac{(L-1) - s2}{(L-1) - r2}$$

#Example find the histogram of the above image matrix after **stretching** the dynamic range from $(105, 175)$ to be $(60, 220)$.

Grey level	**70**	**100**	**110**	**116**	**120**	**150**	**170**	**180**
Grey conunt	10	10	100	500	1000	400	100	80

#Answer

$r_1 = 105, \; r_2 = 175, \; s_1 = 60, \; s_2 = 220$

$r_1 > s_1$ and $r_2 < s_2$

Range of gray Image as:-

1- from 0 To 105

$$f'(x,y) = f(x,y)\frac{s_1}{r_1} = f(x,y)\frac{60}{105} = f(x,y)\frac{4}{7}$$

2- from 105 to 175

$$f'(x,y) = f(x,y)\frac{s_2 - s_1}{r_2 - r_1} + s_1 - r_1\frac{s_2 - s_1}{r_2 - r_1}$$

$$= f(x,y)\frac{16}{7} + 60 - 105 \times \frac{16}{7}$$

$$= f(x,y)\frac{16}{7} - 180$$

3- from 175 To 255

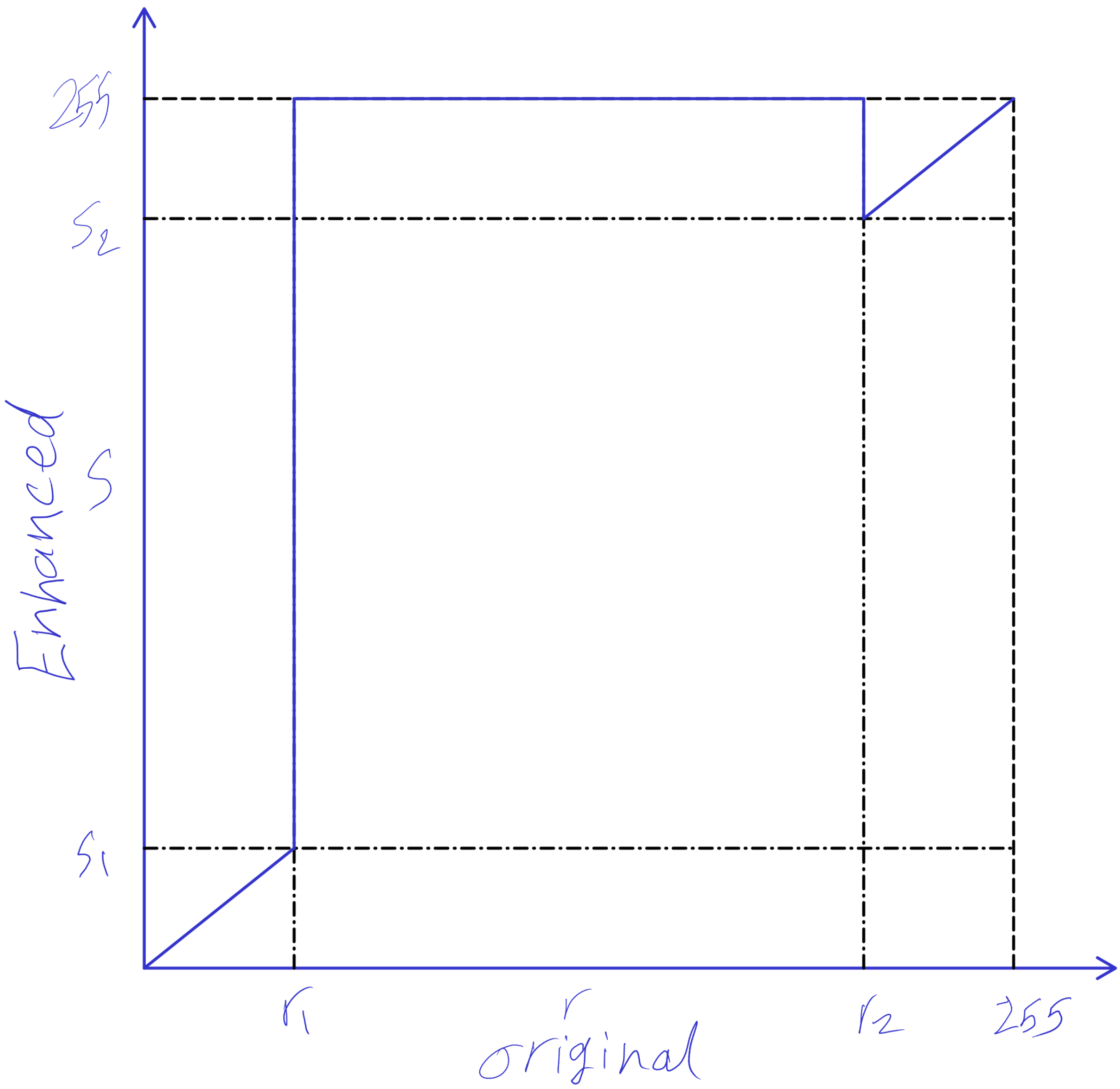
$$f'(x,y) = f(x,y)\frac{255 - s_2}{255 - r_2} + 255 - 255\frac{255 - s_2}{255 - r_2}$$

$$= f(x,y)\frac{7}{16} + \frac{2295}{16} = \frac{7f(x,y) + 2295}{16}$$

Grey level	**40**	**57**	**71**	**85**	**94**	**163**	**209**	**222**
Grey conunt	10	10	100	500	1000	400	100	80

Gray level slicing

To High light range of interest colors/gray values.




```
if(f(i,j)<r2 && f(i,j)>r1)
        fp(i,j)=255
else

        fp(i,j)=f(i,j)
```

#Example find the histogram of the above image matrix after boosting up to rang 125-187

Grey level	70	100	110	116	120	150	170	180
Grey conunt	10	10	100	500	1000	400	100	80

#Answer

Range of gray image

1. first line: 0 --> 125
    - $f'(x, y) = f(x, y)$
2. second line : 125 --> 187

- $f'(x,y) = 255$

3. third line : 187 --> 255
   - $f'(x,y) = f(x,y)$

Grey level	70	100	110	116	120	150	170	180
Grey conunt	10	10	100	500	1000	400	100	80

Grey level	70	100	110	116	120	255
Grey conunt	10	10	100	500	1000	580

Bit plan slicing

An image could be seen as a set of plans where a plain is the set of pixels bit with the same weight #Example for an image with 256 grays will mean each pixel gray assigned 8-bit gray value, this means that such an image could have 8 plains a plain per each bit

Histogram equalization

Normalized Histogram : it gives the probability of each number in the dataset, or we can say that is gives the count of frequency of each element.

Histogram equalization Used for enhancing contrast of image

- full range
- in range
  Full range rules
- Total count = ε count
- probability = $\frac{Graycount}{Totalcount}$
- Cumulative == ε probability
- Equalized = cumulative * 255
  In range rules
- Total count = ε count
- probability = $\frac{Graycount}{Totalcount}$
- Cumulative == ε probability
- Equalized =min + cumulative * (max gray - min gray)

#Example find the full range and in range equalized histogram of the following image matrix.

Grey level	70	100	110	116	120	150	170	180
Grey conunt	10	10	100	500	1000	400	100	80

#Answer (full range)

Gray	Count	Probability	cumulative	Equalized
70	10	10/2140	10\2140	(10\2140)*255 = 1.19
100	10	10/2140	1/107	(1/107)*255 = 2.38
110	100	100/2140	6/107	(6/107)*255 = 14.29
116	500	500/2140	31/107	(31/107)*255 = 73.87
120	1000	1000/2140	81/107	(81/107)*255 = 193.03
150	400	400/2140	101/107	(101/107)*255 = 240.07
170	100	100/2140	106/107	(106/107)*255 = 252.61
180	80	80/2140	1	255
Total	2140	1		

#Answer (in range)

min = 70, max = 180, Δ = (180 - 70) = 110

Gray	Count	Probability	cumulative	Equalized
70	10	10/2140	10\2140	70+(10\2140)*110 = 70.51
100	10	10/2140	1/107	70+(1/107)*110 = 80.28
110	100	100/2140	6/107	70+(6/107)*110 = 76.16
116	500	500/2140	31/107	70+(31/107)*110 = 101.86
120	1000	1000/2140	81/107	70+(81/107)*110 = 153.27
150	400	400/2140	101/107	70+(101/107)*110 = 173.83
170	100	100/2140	106/107	70+(106/107)*110 = 178.97
180	80	80/2140	1	180
Total	2140	1		