Digital Image Processing: Assignment 3

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1 Distance Metrics between RGB Images

Given two same-sized RGB images $\mathbf{I_1}$ and $\mathbf{I_2}$, we calculate the following distances:

1.1 Manhattan Distance

The Manhattan distance (or L1 norm) between the images is calculated as:

$$D_{\text{Manhattan}} = \sum_{i,j,k} |I_{1,i,j,k} - I_{2,i,j,k}|$$

where i, j are the spatial coordinates and k represent the colour channels (R, G, B).

1.2 Euclidean Distance

The Euclidean distance (or L2 norm) between the images is calculated as:

$$D_{\text{Euclidean}} = \sqrt{\sum_{i,j,k} (I_{1,i,j,k} - I_{2,i,j,k})^2}$$

where i, j are the spatial coordinates and k represents the color channels (R, G, B).

1.3 L-infinity Norm

The L-infinity norm (or maximum norm) between the images is:

$$D_{\text{L-infinity}} = \max_{i,j,k} |I_{1,i,j,k} - I_{2,i,j,k}|$$

where i, j are the spatial coordinates and k represents the color channels (R, G, B).

Figure 1: Image 1

Figure 2: Image 2

Distance Metric	**Value**
Manhattan Distance	672477.3
Euclidean Distance	508.8
L-infinity Norm	1.0

Figure 3: Images and distance metrics between them

Figure 4: Image 1

Figure 5: Image 2

Distance Metric	**Value**
Manhattan Distance	905635.0
Euclidean Distance	657.3
L-infinity Norm	1.0

Figure 6: Images and distance metrics between them

2 Binarization and Logical Operations

Consider two same-sized grayscale images $\mathbf{G_1}$ and $\mathbf{G_2}$ that have been binarized using a threshold T. The binarization operation is defined as:

$$B_{i,j} = \begin{cases} 1 & \text{if } G_{i,j} \geq T \\ 0 & \text{if } G_{i,j} < T \end{cases}$$

where B is the binarized image, G is the grayscale image, i, j are the spatial coordinates, and T is the threshold.

Logical operations between the binarized images are:

2.1 Logical AND

$$\text{AND}_{i,j} = B_{1,i,j} \wedge B_{2,i,j}$$

2.2 Logical OR

$$\text{OR}_{i,j} = B_{1,i,j} \vee B_{2,i,j}$$

2.3 Logical XOR

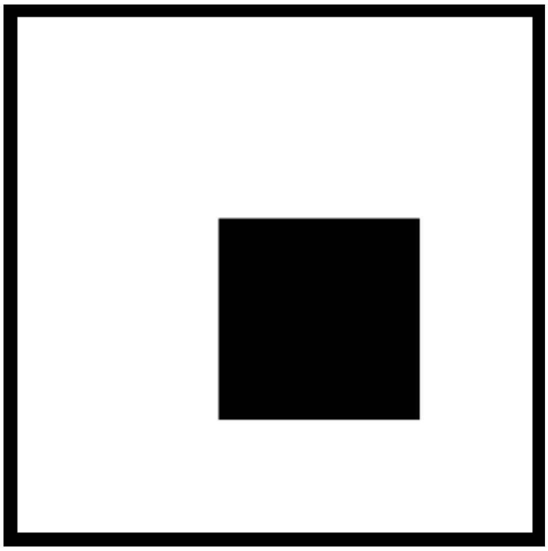
$$\text{XOR}_{i,j} = B_{1,i,j} \oplus B_{2,i,j}$$

where $\wedge$ denotes logical AND, $\vee$ denotes logical OR, and $\oplus$ denotes logical XOR.

(a) origianl Image

(b) img1: binarized image with threshold = 128

(c) img2: binarized image with threshold = 12



(d) img3: white image with a black square.

Figure 7: Various Images

(a) not img1

(b) img1 and img2

(c) img1 or img2

(d) img1 xor img2

Figure 8: Various logical operations between img1, img2 of Figure 7

(a) img1 and img3

(b) img1 or img3

(c) img1 xor img3

Figure 9: Various logical operations between img1, img3 of Figure 7

3 Conclusion

We calculated various distance metrics between two RGB image samples, it is worth noting that we overserved a higher value of Manhattan distance than Euclidean distance and small L-infinity Norm as the distance metric, which also scales up as we take larger images. Also, we perform logical operations which are pixel-wise operations between two images to generate a new image, not, or, and, xor are some of these. Note that "img1 or img2" is img1 , "img1 and img2" is img2 in Figure 8.

Code Availability

All the code used in this project is available in a public GitHub repository. You can access it at: https://github.com/Computer-Science-Practicum/DIP-Lab-Assignment.