Computer Vision Assignment 02: Image Segmentation Report

2 Mean-Shift Algorithm (Total: 40 pts)

2.1 Implement the distance Function

- The distance function between two data points (row vectors) $\mathbf{x_i}$ and $\mathbf{x_j}$ is defined as:

$$dist(\mathbf{x_i}, \mathbf{x_j}) = ||(\mathbf{x_i} - \mathbf{x_j})||_2^2 \tag{1}$$

- The broadcast property of pytorch tensor is applied to simplify the implementation.

2.2 Implement the gaussian Function

- The weights for point $\mathbf{x_j}$ given the center $\mathbf{x_i}$ are defined as (σ is the bandwidth)

$$w_j = \frac{1}{\sqrt{2\pi}\sigma^2} exp(-\frac{dist(\mathbf{x_i}, \mathbf{x_j})}{2\sigma^2}) \tag{2}$$

2.3 Implement the update point Function

- The update rule of $\mathbf{x_i}$ Is:

$$\mathbf{x_i} = \frac{\sum_{j=0}^{n} w_j \mathbf{x_j}}{\sum_{j=0}^{n} w_j} = \frac{1}{\sum_{j=0}^{n} w_j} \mathbf{w}_{\mathbf{x}_i} X \tag{3}$$

2.4 Accelerating the Naive Implementation

- Running time of slow approach (CPU)

```
>>> python mean-shift.py
Elapsed time for mean-shift: 13.373154878616333
```

- Running time of fast approach (CPU) => obersevation: As the batch size increasing, the speed of the algorithm first increases and then decreases.

```
(batch_size = 100)
>>> python mean-shift.py
Elapsed time for mean-shift: 13.373154878616333
(batch_size = 500)
>>> python mean-shift.py
Elapsed time for mean-shift: 7.699587821960449
(batch_size = 1000)
>>> python mean-shift.py
lapsed time for mean-shift: 8.911517858505249
```