Image Processing and Pattern Recognition—Homework 1

Tobias Hamedl—11808141

June 6, 2022

1 Guided Image Filter

At the beginning of the exercise we implement the guided image filter. For that we assume that we have a window with a size of (2r + 1) × (2r + 1) centered at pixel k, so we calculate q_i by

$$q_i = a_k I_i + b_k, \forall i \in \omega_k \tag{1}$$

By minimizing

$$E(a_k, b_k) = \sum_{i \in \omega_k} ((a_k I_i + b_k - p_i)^2 + \epsilon a_k^2), \tag{2}$$

our values a_k and b_k are then given by

$$a_k = \frac{\frac{1}{|\omega|} \sum_{i \in \omega_k} I_i p_i - \mu_k \overline{p}_k}{\sigma_k^2 + \epsilon}, \tag{3}$$

and

$$b_k = \overline{p}_k - a_k \mu_k, \tag{4}$$

We get value a_k and the variance by computing the mean. We implement the computation of mean easily using the function `uniform_filter()` from `scipy.ndimage.filters`. Now we can calculate our q_i

$$q_i = \frac{1}{|\omega|} \sum_{k: i \in \omega_k} a_k I_i + b_k = \overline{a}_i I_i + \overline{b}_i, \tag{5}$$

where $\overline{a}_i = \sum_{k \in \omega_i} a_k$ and similarly $\overline{b}_i = \sum_{k \in \omega_i} b_k$.

2 Detail Enhancement

Detail Enhancement can be performed by

$$p_i^{de} = c^{de}(p_i - q_i) + q_i, \tag{6}$$

where c^{de} is the detail enhancement coefficient, and q is the output of the guided filter when using p as both the input and the guide image. We implement the function `detail_enhancement()` by calling our `guided_image_filtering()` function to get our q. The equation above makes sense, because our image is decomposed into our structure which is $(p_i - q_i)$ and details q_i. Recombined with our detail enhancement coefficient c^{de} it leads to a detail enhanced image p_i^{de}