3D Data Processing Lab1

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Topic: Semi Global Stereo Matching with Monocular Disparity Initial Guess.

Goal: The objective of this exercise is to implement both an aggregation and a compute_path_cost function for the Semi Global Matching (SGM) algorithm. This implementation aims to facilitate successful disparity estimation. Additionally, we will utilize the compute_disparity function to further refine our results.

compute_path_cost function:

In this function according to slides of the course I calculate the path cost in all disparity and all direction.

Here is the formula:

$$E(p_i, d) = E_{data}(p_i, d) + E_{smooth}(p_i, p_{i-1}) - \min_{0 \le \Delta \le d_{\max}} E(p_{i-1}, \Delta)$$

Current pixel — Previous pixel along direction — Restrict the range of resulting values, without affecting the minimization procedure

where:

$$E_{smooth}(p, q) = \min \begin{cases} E(q, f_q) & \text{if } f_p = f_q \\ E(q, f_q) + c_1 & \text{if } |f_p - f_q| = 1 \\ \min_{0 \le \Delta \le d_{\max}} E(q, \Delta) + c_2(p, q) & \text{if } |f_p - f_q| > 1 \end{cases}$$

For this part, we first check if the pixel is located at the corner (boundary) or not. If the pixel is at the corner, we evaluate only the "cost_". In other words, we solely consider the E data. Otherwise, if the pixel is not at the corner, we calculate the E smooth and sum them together for all disparities.

Aggregation function:

In this function, I need to initialize the variables start_x, start_y, end_x, end_y, step_x, and step_y. Firstly, I determine the direction in both X and Y. We know that the possible values for dir_x and dir_y are 0, 1, or -1.

The values 0 and 1 act exactly similarly to each other. Then, based on the structure of the direction in the lab1 slides, I assign values to start_x, start_y, end_x, end_y, step_x, and step_y.

compute_disparity function:

In this function, we set a constraint to reach a disparity with good confidence and save them to good_disparities (smg) and unscaled_disparities (mono) variables. Then, based on the formula in the course, we calculate X, which contains h and k.

$$x = (A^T A)^{-1} A^T b$$

Then using this data Scale initial guess disparities and update low-confidence SGM disparities

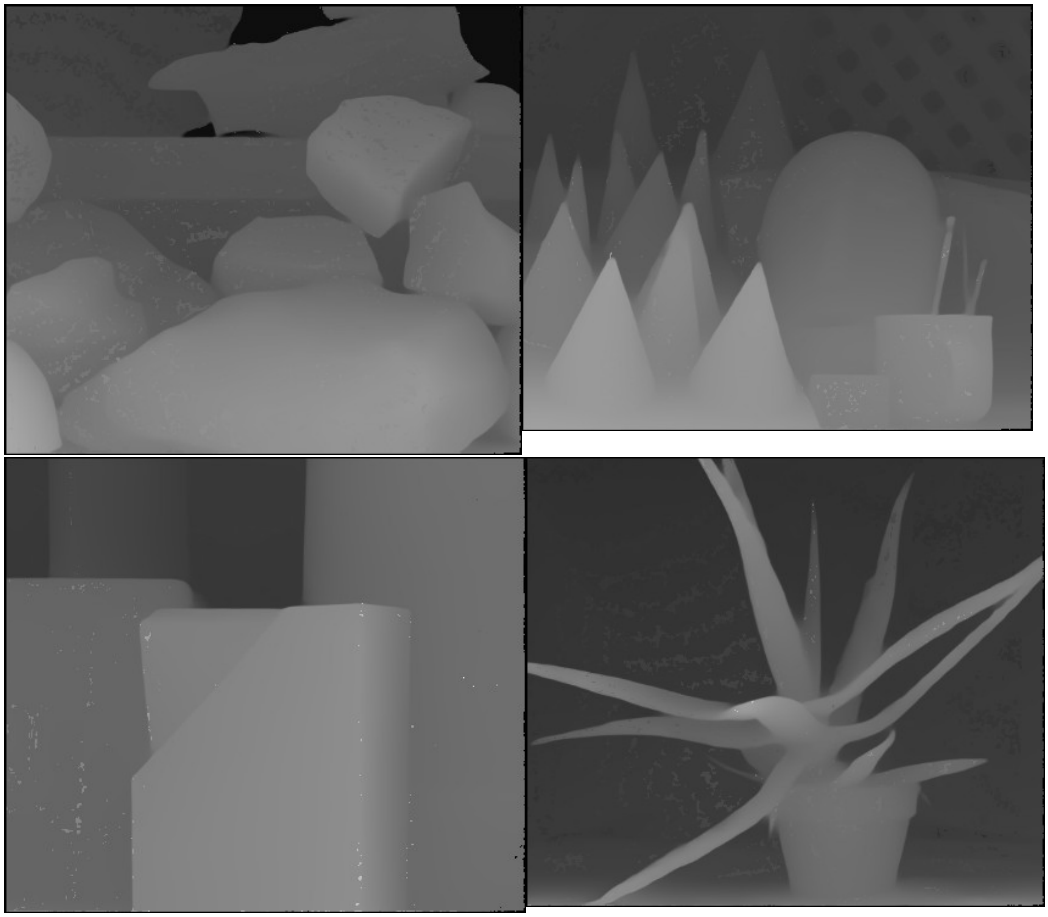
With Refinement

Data item	Aloe	Cones	Plastic	Rocks1
MSE	41	52	680	57
Disparity	95	85	95	90

Without Refinement

Data item	Aloe	Cones	Plastic	Rocks1
MSE	149	483	897	573
Disparity	95	85	95	90

Result of With Refinement:



Result of Without Refinement: