SLAM HW4 Writeup Qishun Yu

2.1

the condition of u, v, d is.

$$0 \le u < w$$
$$0 \le v < h$$
$$0 \le d$$

$|p - q| < d_{thr}$ is necessary because we want to set a limit between the project points and unprojected points. Large difference indicates the point is distorted during the process. (the $(R@p + t)$ is wrong)

2.2

$$r_i = n_{q_i}^T (\delta R P_i' + \delta t - q_i)$$

$$= n_{q_i}^T \left( \begin{bmatrix} 1 & -\gamma & \beta \\ \gamma & 1 & -\alpha \\ -\beta & \alpha & 1 \end{bmatrix} P_i' + \begin{bmatrix} t_x \\ t_y \\ t_z \end{bmatrix} - q_i \right)$$

$$= n_{q_i}^T \left( \begin{bmatrix} 0 & -\gamma & \beta \\ \gamma & 0 & -\alpha \\ -\beta & \alpha & 0 \end{bmatrix} P_i' + \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} P_i' + \begin{bmatrix} t_x \\ t_y \\ t_z \end{bmatrix} - q_i \right)$$

$$= n_{q_i}^T \left( \begin{bmatrix} 0 & -\gamma & \beta \\ \gamma & 0 & -\alpha \\ -\beta & \alpha & 0 \end{bmatrix} p_i' + \begin{bmatrix} t_x \\ t_y \\ t_z \end{bmatrix} \right) + n_{q_i}^T (p_i' - q_i)$$

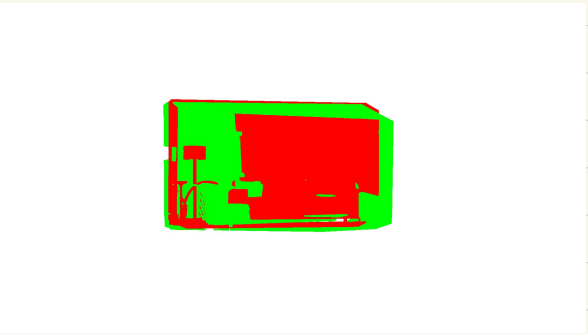
$$= n_{q_i}^T \underbrace{\begin{bmatrix} -p_i' \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}}_{A_i} \cdot \begin{bmatrix} \alpha \\ \beta \\ \gamma \\ t_x \\ t_y \\ t_z \end{bmatrix} + \underbrace{n_{q_i}^T (p_i' - q_i)}_{b_i}$$

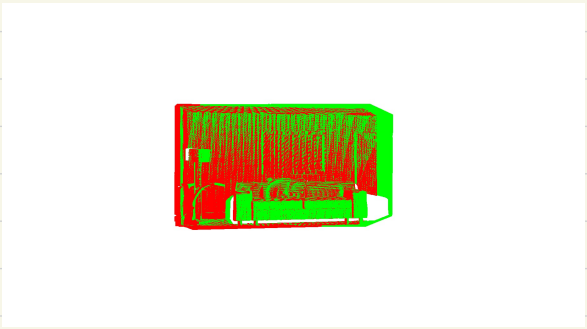
2.3

$$\text{argmin} \| A_i \begin{bmatrix} \alpha \\ \beta \\ \gamma \\ t_x \\ t_y \\ t_z \end{bmatrix} + B_i \|^2$$

$$A_i^T A_i \begin{bmatrix} \alpha \\ \beta \\ \gamma \\ t_x \\ t_y \\ t_z \end{bmatrix} = A_i^T b_i$$

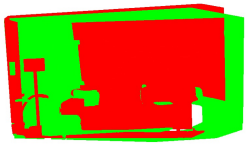
Using frame 10 and 50





The optimization is successful because the minimization converged. We can see that from the average loss.

Using frame 10 and 100



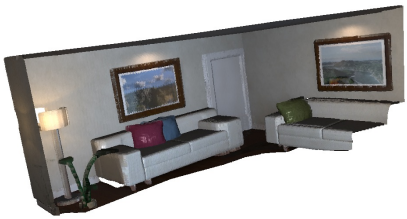
The optimization failed because the minimization didn't converge. We can tell from the average loss doesn't change. Also the number of inliers are way smaller than the previous case.

3.2

$$\text{position} = \frac{w \cdot p + 1 \cdot (R_c^w \cdot q + t_c^w)}{w + 1}$$

$$\text{normal} = \frac{w \cdot n_p + 1 \cdot (R_c^w \cdot n_q + t_c^w)}{w + 1}$$

3.4



Total number of points is 1362143
The compression ratio is 8.87%

4.

The source is the map, the target is the input RGB-D frame.
We can't swap their roles because we want to project the 3D map into the input frame using the projective data association.