visual navigation exercise 04

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1 Exercise 3

1.1 What does a robust loss function such as Huber do here?

For an optimization problem, some outlier input might lead to deviation of solution from correctness. To reduce the influence of these outlier, we should use some loss functions to constrain them. Some outlier data will make the residual very large. When the residual is very large, The square of it will become larger. As a result, to minimize the loss, optimizer might consider more the impact of these outliers. So the solution will become erroneous. The idea of robust loss function is that it keeps the influence of small residual to the error function, but decreases the influence of square of large residual to the error function. For example, Huber loss is a piece wise function which is linear between 0 and 1 but taking square root in domain larger than 1.

1.2 Why should we use loss function here but not in exercise 2?

In exercise 2, the position of points in world frame are obtained from aprilgrid board which can be treated as ground truth position because we can use ruler to measure the relative position of key points between one another. So as input data there are no outlier in them. But in exercise 4 our point positions in the world frame are triangulated with key points' 2 dimensional data from two images. The triangulation of key points and the procedure of matches might be erroneous which creates outliers. Therefore we need a more robust way to reduce the impact of these errors.

2 Exercise 4

2.1 What are the criteria of detecting outliers?

- First criterion: huge re-projection error. It might be caused by wrong matches. It can lead to the creation of wrong map.
- Second criterion: too large re-projection error. It might be caused by triangulation of landmarks that converged to local minimum. It can pull other points away from correct position.
- Third criterion: too small distance to camera. It might be caused by triangulation of landmarks that converged to local minimum or wrong matches. It can create noise in the map.
- Fourth criterion: too small z coordinate. It might be caused by triangulation of landmarks that converged to local minimum or wrong matches. It can create noise in the map.

3 Exercise 5

164 cameras are added to this map. It takes 2 minutes to compute the whole map. The most time consuming step is optimization, the second is key points matches between image pair at the beginning. To improve the speed we can make the optimization parallel. That is to say, we can divide the optimization problem into different smaller problems and optimize them at the same time. This is achievable because each iteration step in optimization does

not consume a lot of computing resources. So parallel computing will achieve a faster performance than serial computing.