

# Solution of 第四节课习题 (macOS 平台)

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## 1 习题说明

## 2 图像去畸变

实验结果 (图 1):



图 1: 去畸变后图像

### 3 双目视差的使用

$z$  计算公式 ( $d$  为视差):

$$z = \frac{fb}{d} \quad (1)$$

实验结果 (图 2):

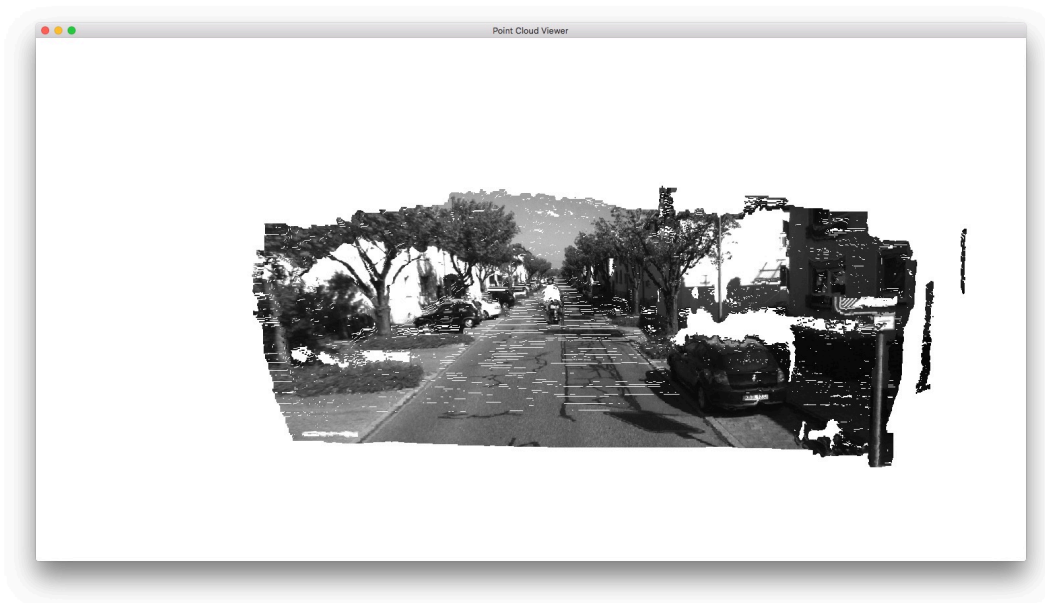


图 2: 生成点云

### 4 矩阵微分

1.

$$\frac{d(Ax)}{dx} = A \quad (2)$$

2.

$$\frac{d(x^T Ax)}{dx} = (A^T + A)x \quad (3)$$

3. 证明: 左边等于

$$x^T Ax = [x_1, \dots, x_n] \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \cdots & \cdots & \cdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix} \begin{bmatrix} x_1 \\ \cdots \\ x_n \end{bmatrix} = \sum_{i=1}^n \sum_{j=1}^n a_{ij} x_i x_j$$

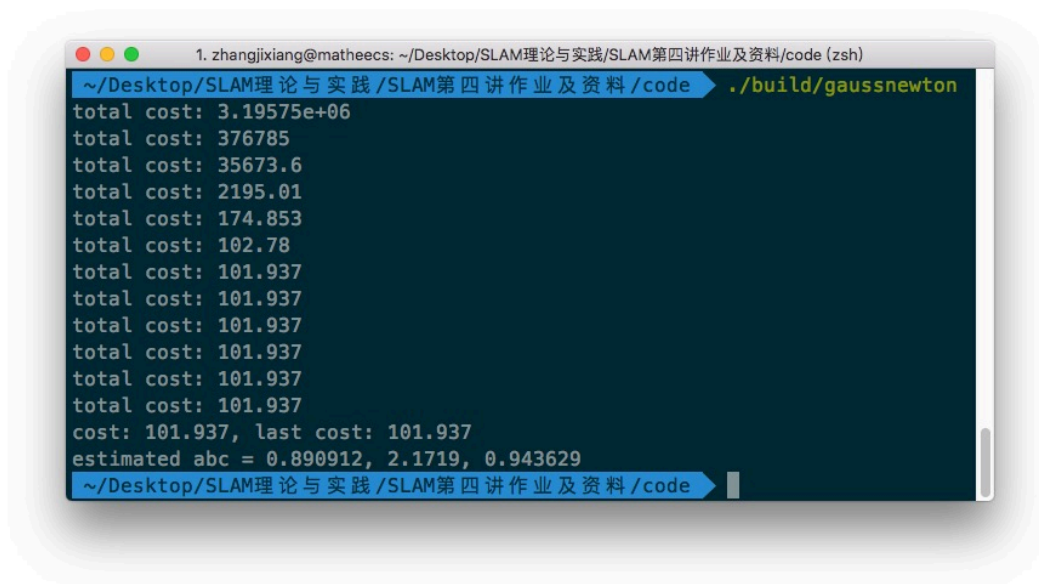
右边等于

$$tr(Axx^T) = tr \left( \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \cdots & \cdots & \cdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix} \begin{bmatrix} x_1 x_1 & x_2 x_1 & \cdots & x_n x_1 \\ \cdots & \cdots & \cdots & \cdots \\ x_1 x_n & x_2 x_n & \cdots & x_n x_n \end{bmatrix} \right) = \sum_{i=1}^n \sum_{j=1}^n a_{ij} x_i x_j$$

故左边 = 右边。■

## 5 高斯牛顿法的曲线拟合实验

实验结果 (图 3):

A terminal window with a dark blue background and white text. The window title is "1. zhangjixiang@matheecs: ~/Desktop/SLAM理论与实践/SLAM第四讲作业及资料/code (zsh)". The prompt is "~/Desktop/SLAM理论与实践/SLAM第四讲作业及资料/code" followed by a blue arrow pointing to the command "./build/gaussnewton". The output shows a series of "total cost" values: 3.19575e+06, 376785, 35673.6, 2195.01, 174.853, 102.78, 101.937, 101.937, 101.937, 101.937, 101.937, 101.937, 101.937. It then shows "cost: 101.937, last cost: 101.937" and "estimated abc = 0.890912, 2.1719, 0.943629". The prompt is again "~/Desktop/SLAM理论与实践/SLAM第四讲作业及资料/code" followed by a blue arrow.

```
1. zhangjixiang@matheecs: ~/Desktop/SLAM理论与实践/SLAM第四讲作业及资料/code (zsh)
~/Desktop/SLAM理论与实践/SLAM第四讲作业及资料/code ➤ ./build/gaussnewton
total cost: 3.19575e+06
total cost: 376785
total cost: 35673.6
total cost: 2195.01
total cost: 174.853
total cost: 102.78
total cost: 101.937
total cost: 101.937
total cost: 101.937
total cost: 101.937
total cost: 101.937
total cost: 101.937
total cost: 101.937
cost: 101.937, last cost: 101.937
estimated abc = 0.890912, 2.1719, 0.943629
~/Desktop/SLAM理论与实践/SLAM第四讲作业及资料/code ➤
```

图 3: Gauss-Newton 运行结果

## 6 \* 批量最大似然估计

令状态变量  $x = [x_0, x_1, x_2, x_3]^T$ , 观测为  $z = [v_1, v_2, v_3, y_1, y_2, y_3]^T$

1.  $e = z - Hx$

$$H = \begin{bmatrix} -1 & 1 & 0 & 0 \\ 0 & -1 & 1 & 0 \\ 0 & 0 & -1 & 1 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}_{6 \times 4} \quad (4)$$

2. 信息矩阵

$$W = \begin{bmatrix} \mathbf{Q} & 0 & 0 & 0 & 0 & 0 \\ 0 & \mathbf{Q} & 0 & 0 & 0 & 0 \\ 0 & 0 & \mathbf{Q} & 0 & 0 & 0 \\ 0 & 0 & 0 & \mathbf{R} & 0 & 0 \\ 0 & 0 & 0 & 0 & \mathbf{R} & 0 \\ 0 & 0 & 0 & 0 & 0 & \mathbf{R} \end{bmatrix}_{6 \times 6} \quad (5)$$

3. 存在唯一解:

$$x = (H^T W^{-1} H)^{-1} H^T W^{-1} z \quad (6)$$