第四次作业

第一题：图像去畸变

代码

```
        // 先归一化
            double image_x=(u-cx)/fx;
            double image_y=(v-cy)/fy;
            double r = sqrt((image_x*image_x)+(image_y*image_y));
        //径向畸变
            double step1_x=image_x*(1+k1*r*r+k2*r*r*r*r);
            double step1_y=image_y*(1+k1*r*r+k2*r*r*r*r);
        //切向畸变+径向畸变
            double step2_x=2*p1*image_x*image_y+p2*
(r*r+2*image_x*image_x)+step1_x;
            double step2_y=p1*
(r*r+2*image_y*image_y)+2*p2*image_x*image_y+step1_y;
        //赋值
            u_distorted=step2_x*fx+cx;
            v_distorted=step2_y*fy+cy;
```

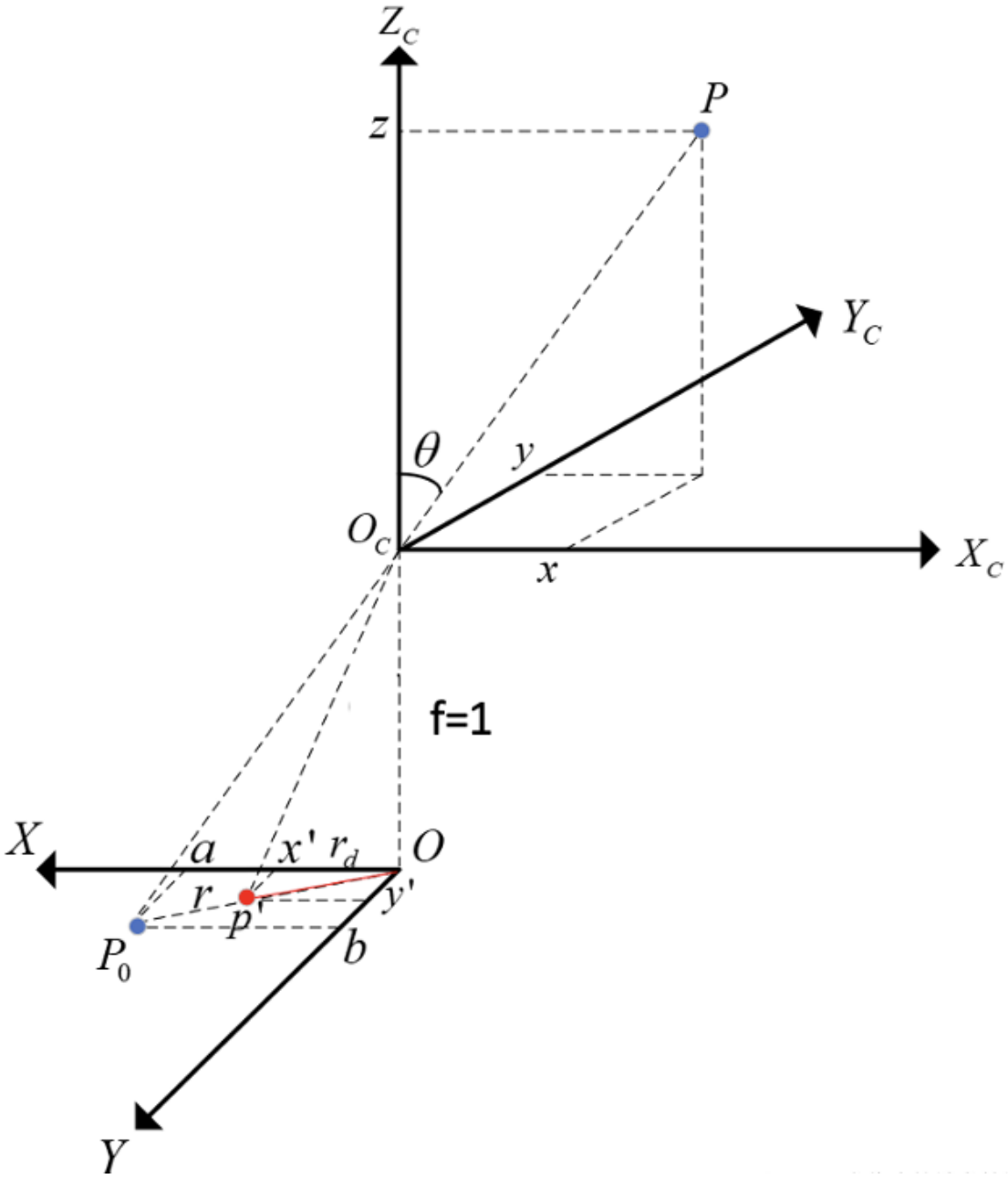
结果图

第二题：鱼眼模型与去畸变

2.1 鱼眼相机与普通相机相比在SLAM方面的优势

能看的视野范围更广泛，对于提取图像特征以及追踪场景变化有更好性能。

2.2 描述鱼眼畸变模型和针孔相机的畸变模型的区别



等距投影模型

鱼眼镜头的畸变矫正.

1. $\vec{X}_w$ 为三维空间中一点

$$\vec{X}_c = T_{cw} \cdot \vec{X}_w \qquad \vec{X}_c = \begin{pmatrix} x_c \\ y_c \\ z_c \\ 1 \end{pmatrix}$$

2. 归一化至 $f=1$ 平面.

$$a = \frac{x_c}{z_c} \qquad b = \frac{y_c}{z_c}$$

3. 记 $r^2 = a^2 + b^2$. $\theta = \arctan(r)$

4. 畸变.

$$\theta_d = \theta(1 + k_1\theta^2 + k_2\theta^4 + k_3\theta^6 + k_4\theta^8)$$

5. distorted point are $(x', y')^T$

$$x' = \frac{r_d}{r} a = \frac{\theta_d}{r} \cdot a$$

$$y' = \frac{r_d}{r} b = \frac{\theta_d}{r} \cdot b.$$

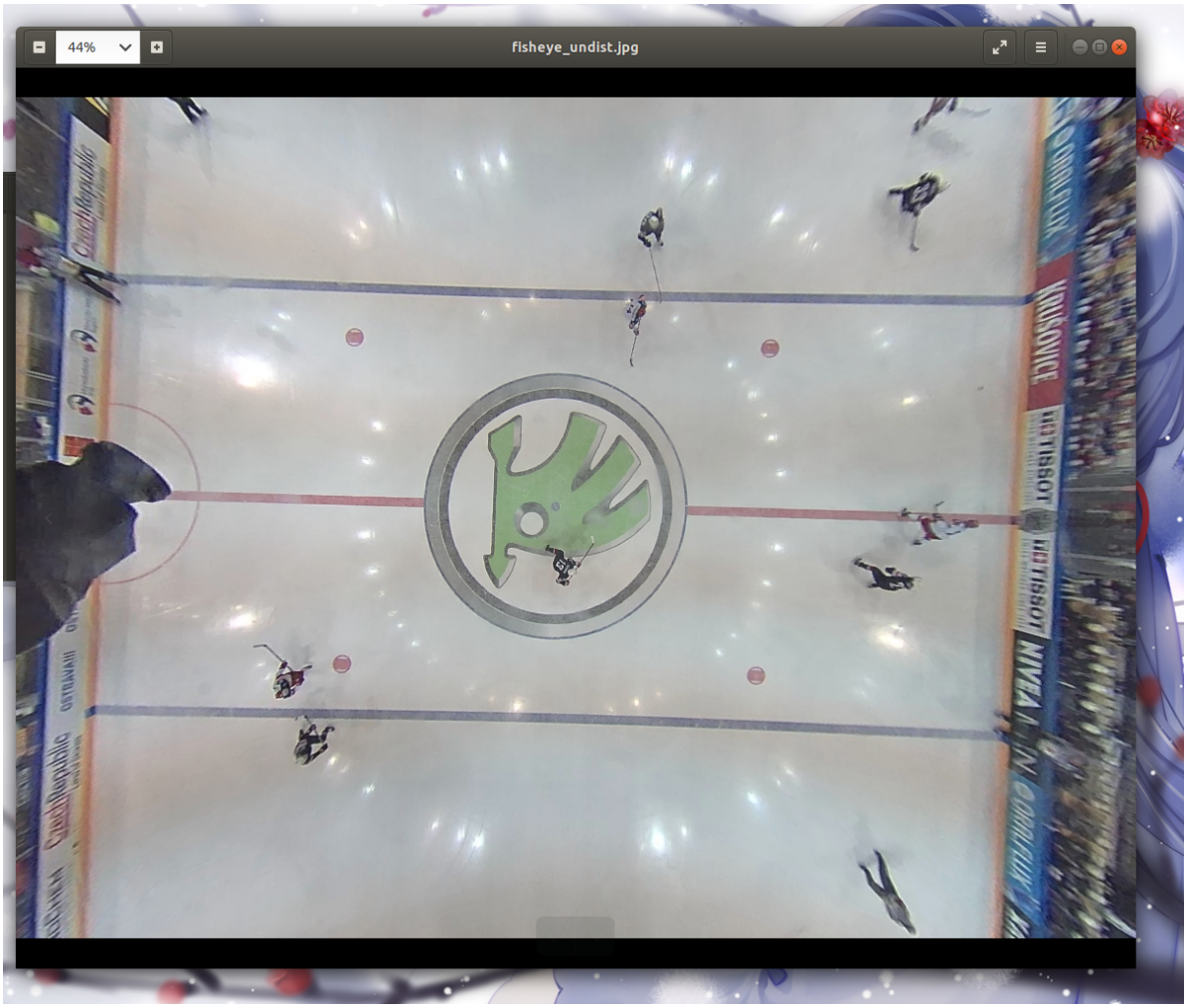
6. 归一化平面 $\longrightarrow$ 像素平面.

$$\frac{u - c_x}{f_x} = x' \qquad a = \frac{r}{\theta_d} x'$$

$$\frac{v - c_y}{f_y} = y' \qquad b = \frac{r}{\theta_d} y'$$

2.3 图片矫正

```
    double x=(u-cx)/fx;
    double y=(v-cy)/fy;
    double ang_d= atan(sqrt(x*x+y*y));
    double ang=
ang_d/(1+k1*ang_d*ang_d+k2*ang_d*ang_d*ang_d*ang_d+k3*ang_d*ang_d*ang_d*ang_d*ang
_d*ang_d+k4*ang_d*ang_d*ang_d*ang_d*ang_d*ang_d*ang_d*ang_d);
    double r= tan(ang);
    double x_distorted=ang/sqrt(x*x+y*y)*x;
    double y_distorted=ang/sqrt(x*x+y*y)*y;
    u_distorted=fx*(x_distorted+0.01*y_distorted)+cx;
    v_distorted=fy*y_distorted+cy;
```



2.4 畸变参数为零去畸变的原理

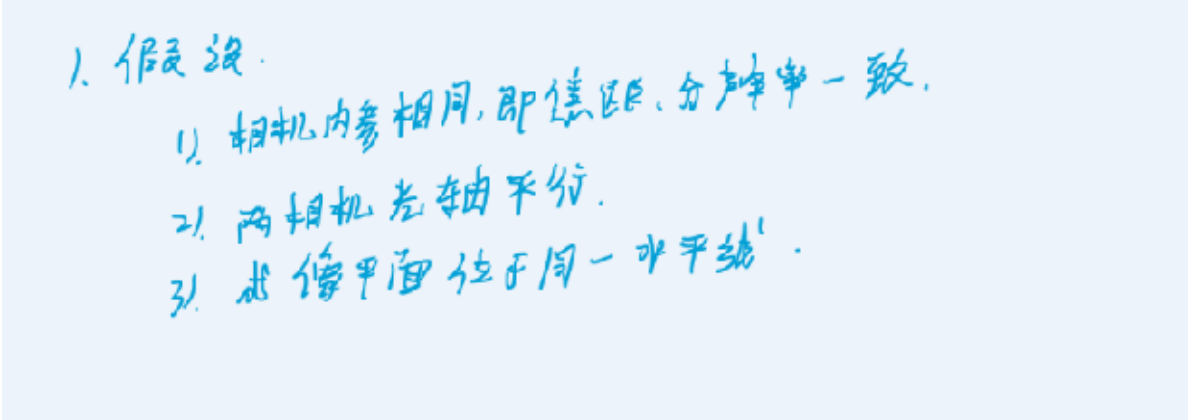
鱼眼相机的畸变模型为多阶泰勒展开，$K_1 \dots K_4$取零相当于只取了第一项，只会影响精度不会影响功能。

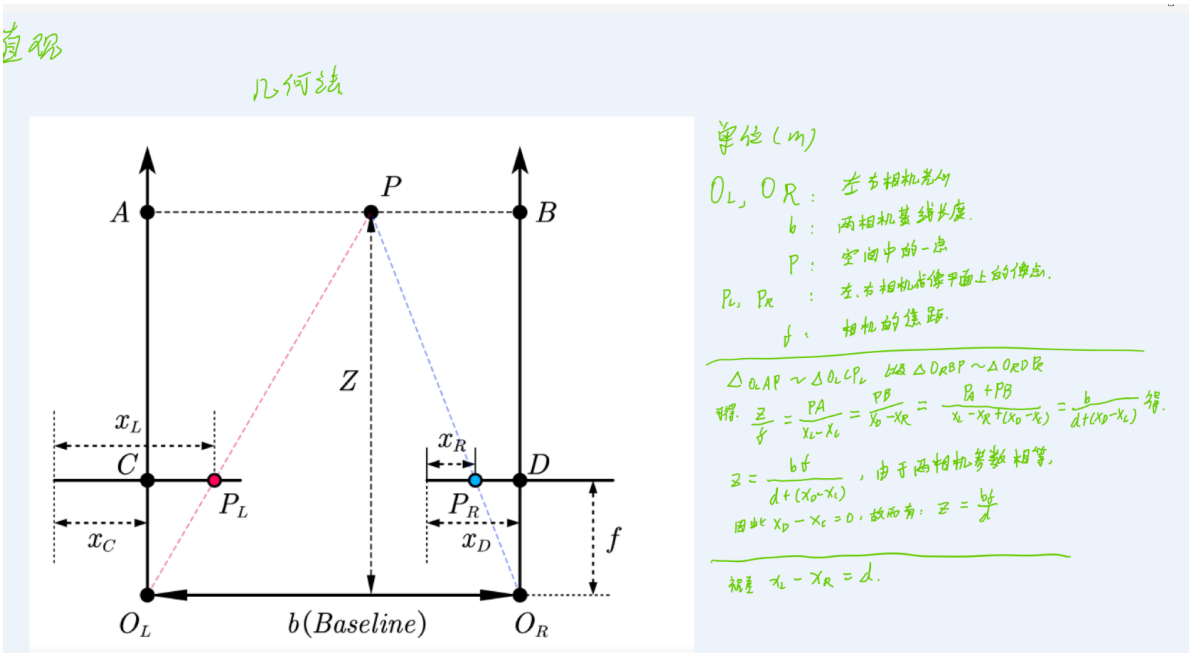
2.5 图片损失

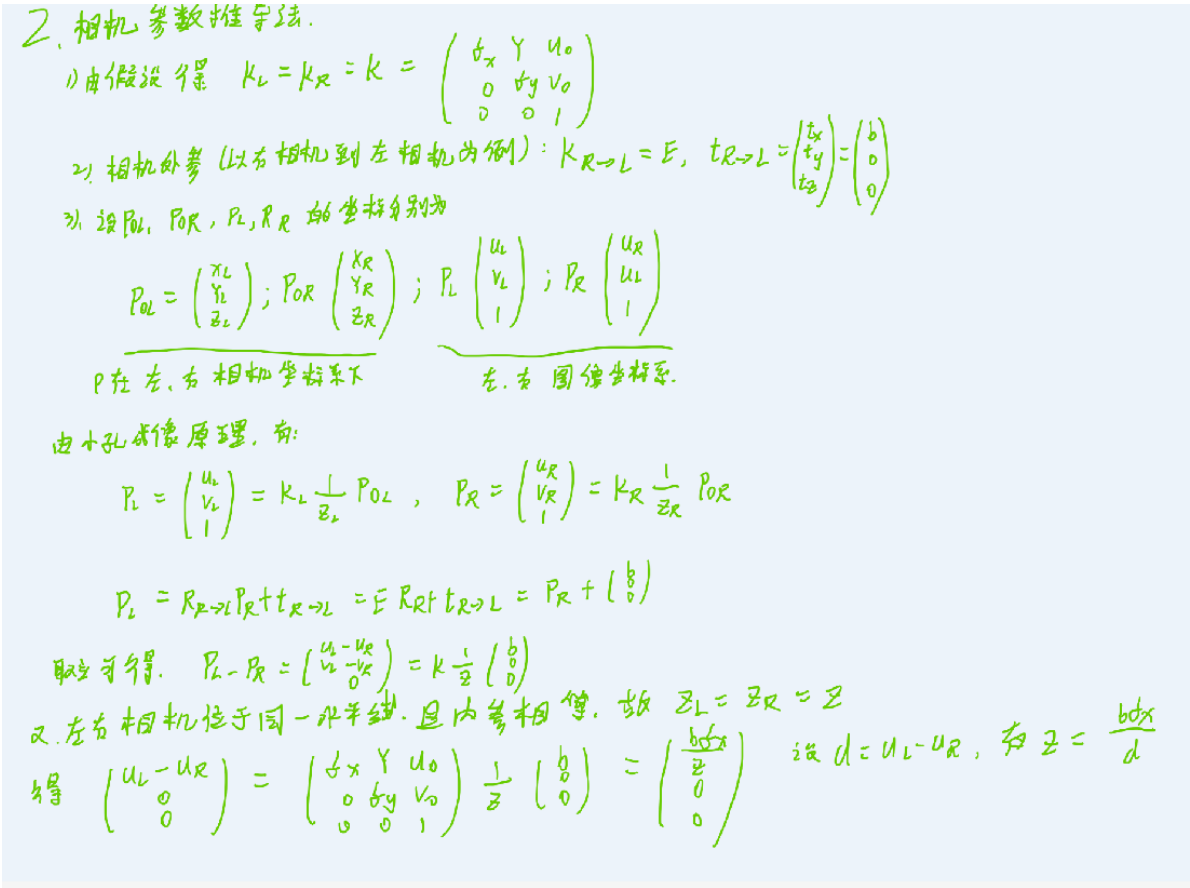
鱼眼图一般为圆形，边缘的信息被压缩的很密，经过去除畸变后原图中间的部分会被保留的很好，而边缘位置一般都会被拉伸的很严重、视觉效果差，所以通常会进行切除，因此肯定会带来图像内容的损失。可以通过增大去畸变时图像的尺寸，或者使用单目相机和鱼眼相机图像进行融合，补全丢失的信息。

第三题：双目视差的使用

3.1 视差原理的证明







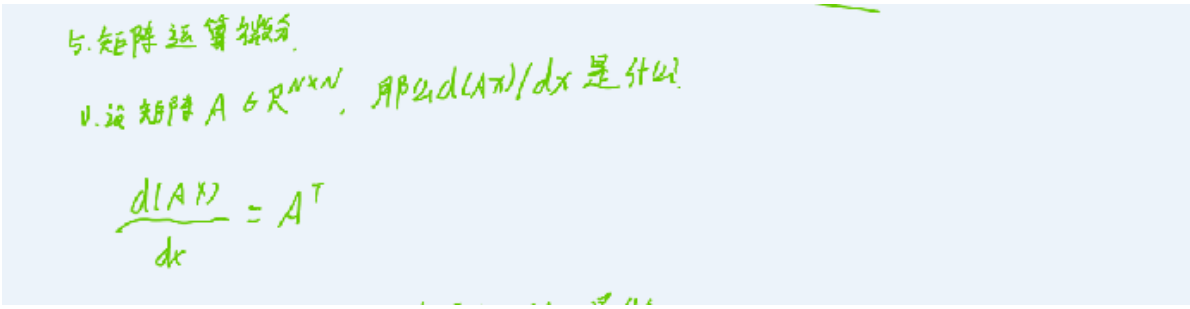
3.2 代码实现

```
double depth = fx * d / (disparity.at<char>(v,u));
double x = (u - cx)/fx * depth;
double y = (v - cy)/fy * depth;
point[0] = x;
point[1] = y;
point[2] = z;
```

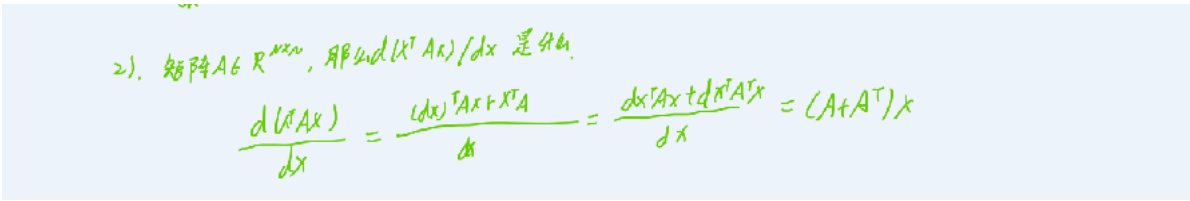
//pangolin 一生之敌了，属于是 目前猜测是因为ros的原因 准备找台电脑 从零开始。。。

第四题：矩阵运算微分

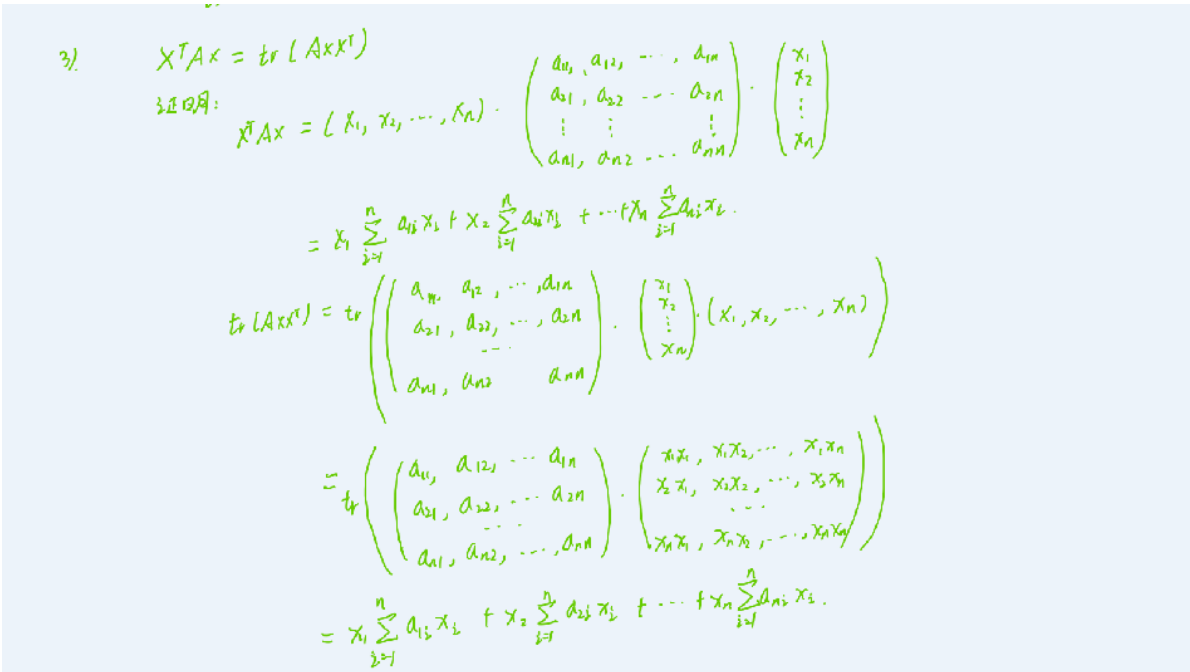
4.1 矩阵$A \in R^{N \times N}$,那么$d(A_X)/d_x$是什么？



4.2 矩阵$A \in R^{N \times N}$,那么$d(X^T A_X)/d_x$是什么？

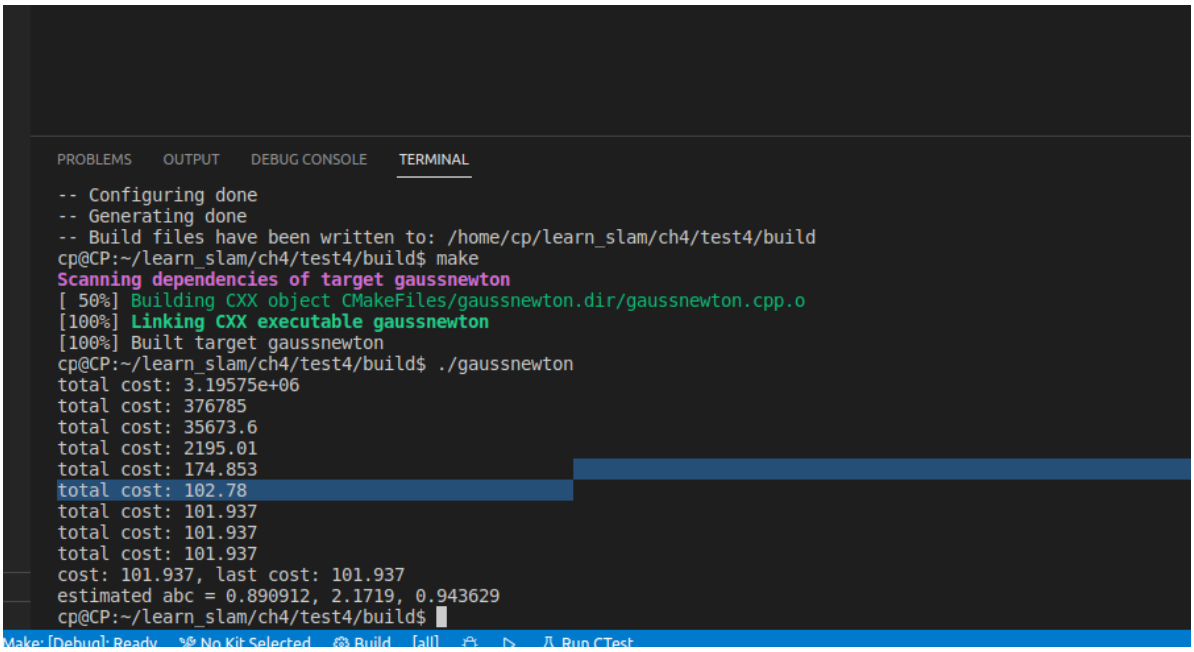


4.3 证明

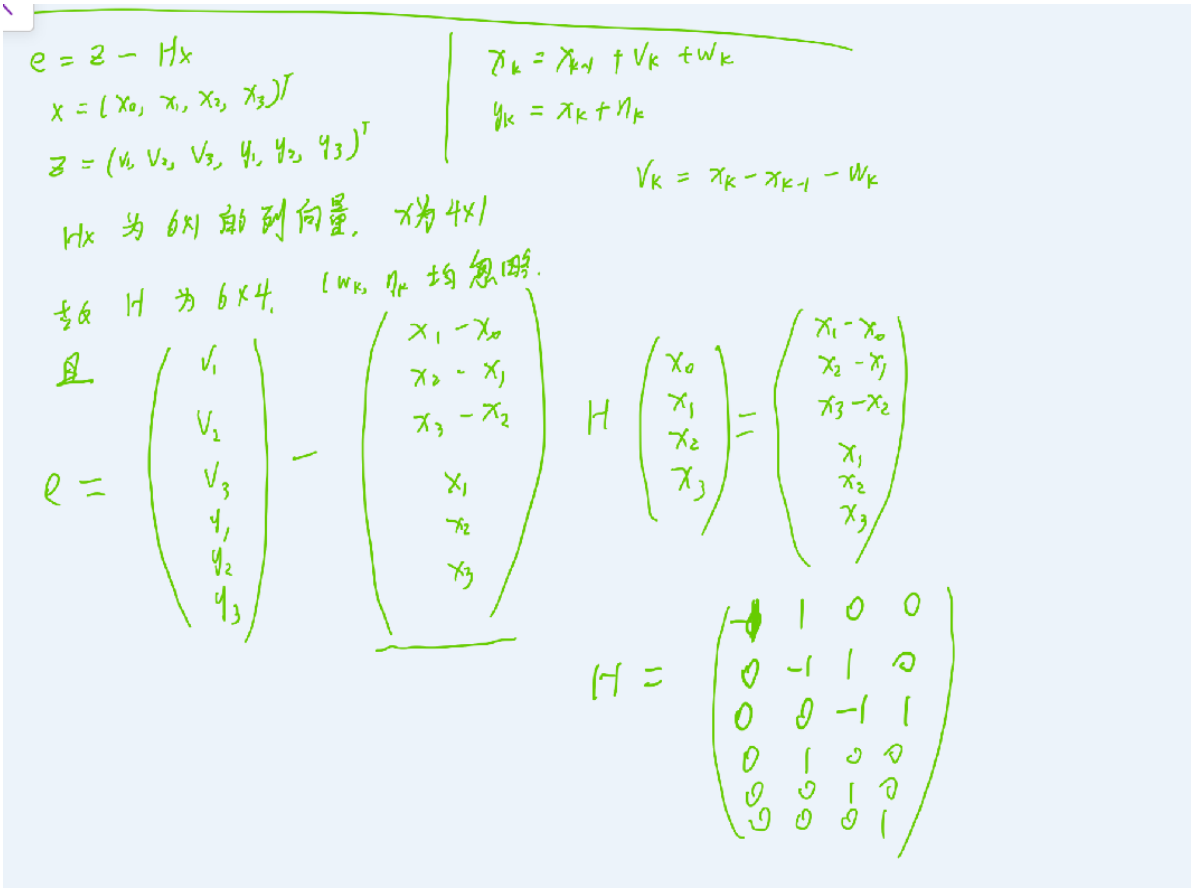


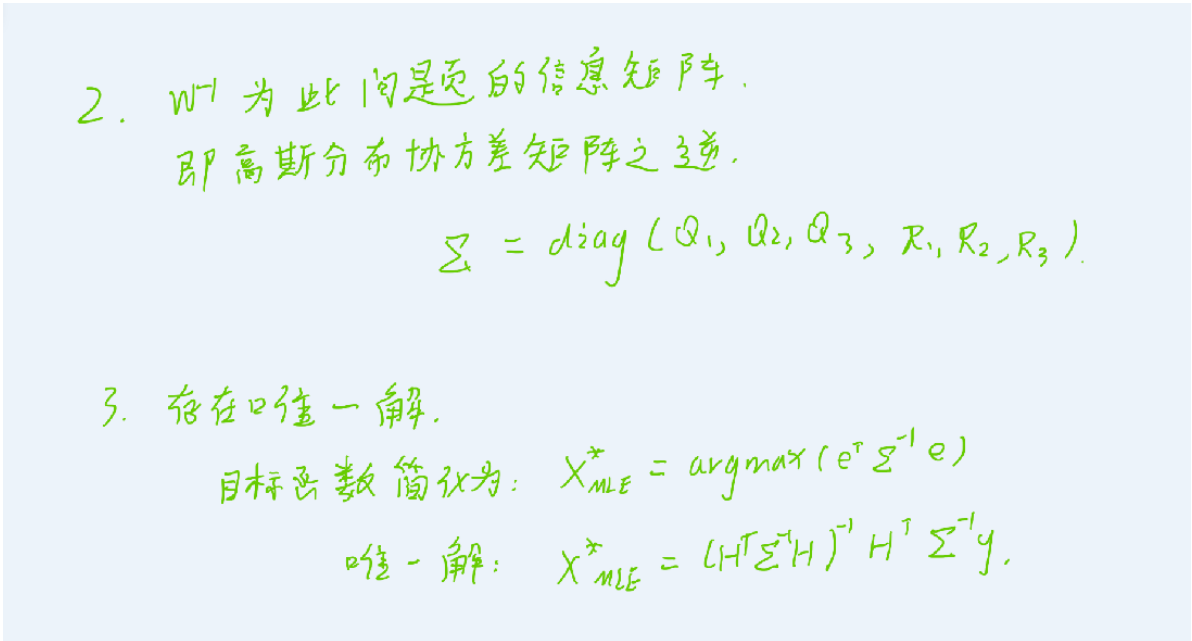
第五题： 高斯牛顿法的曲线拟合实验

```
double error = 0;   // 第i个数据点的计算误差
Vector3d J; // 雅可比矩阵
J[0] = -xi*xi*exp(ae * xi * xi + be*xi + ce);  // de/da
J[1] = -xi* exp(ae * xi * xi + be*xi + ce);  // de/db
J[2] = -exp(ae * xi * xi + be*xi + ce);  // de/dc
H += J * J.transpose(); // GN近似的H
b += -error * J;
```



第六题：批量最大似然估计


e = z − Hx
x = (x0, x1, x2, x3)^T
z = (v1, v2, v3, y1, y2, y3)^T
Hx 为 6×1 的列向量，x为 4×1
故 H 为 6×4.
且
e =
H
H =


2. W^-1 为此问题的信息矩阵，
即高斯分布协方差矩阵之逆.
Σ = diag(Q1, Q2, Q3, R1, R2, R3)
3. 存在唯一解.
目标函数简化为：
唯一解：

参考链接

2.2

https://blog.csdn.net/u011852872/article/details/117340713?spm=1001.2101.3001.6650.5&utm_medium=distribute.pc_relevant.none-task-blog-2%7Edefault%7EOPENSEARCH%7ERate-6-117340713-blog-122014468.pc_relevant_multi_platform_whitelistv4&depth_1-utm_source=distribute.pc_relevant.none-task-blog-2%7Edefault%7EOPENSEARCH%7ERate-6-117340713-blog-122014468.pc_relevant_multi_platform_whitelistv4&utm_relevant_index=10

3.1

https://blog.csdn.net/qq_40918859/article/details/123984329

结语