



# IUAVI

天津大学大学生创新创业训练计划项目

## 无人机自主避障

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孙明睿

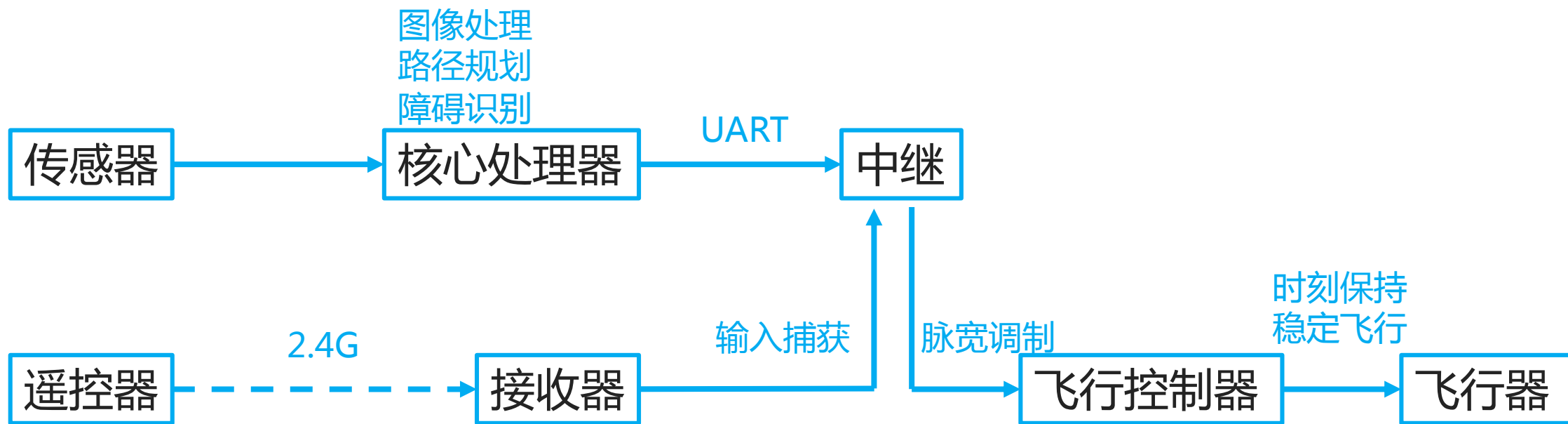


**目标：**实现无人飞行器的自主避障飞行

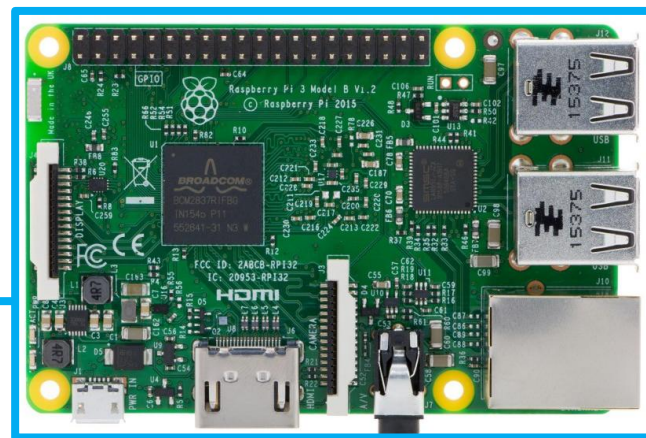
**方案：**基于双目视觉

**特点：**结构简单，方便移植





ARM Cortex-A53



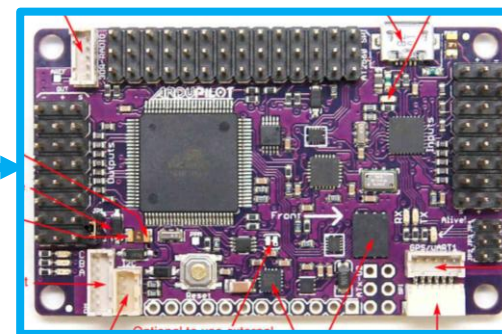
传感器

ARM Cortex-M3



UART

16bit MCU



飞行器

2.4G

遥控器

接收器

相机标定

读入参数  
旋转/平移

计算校正参数

立体匹配

路径

障碍物检测

计算距离

视差图

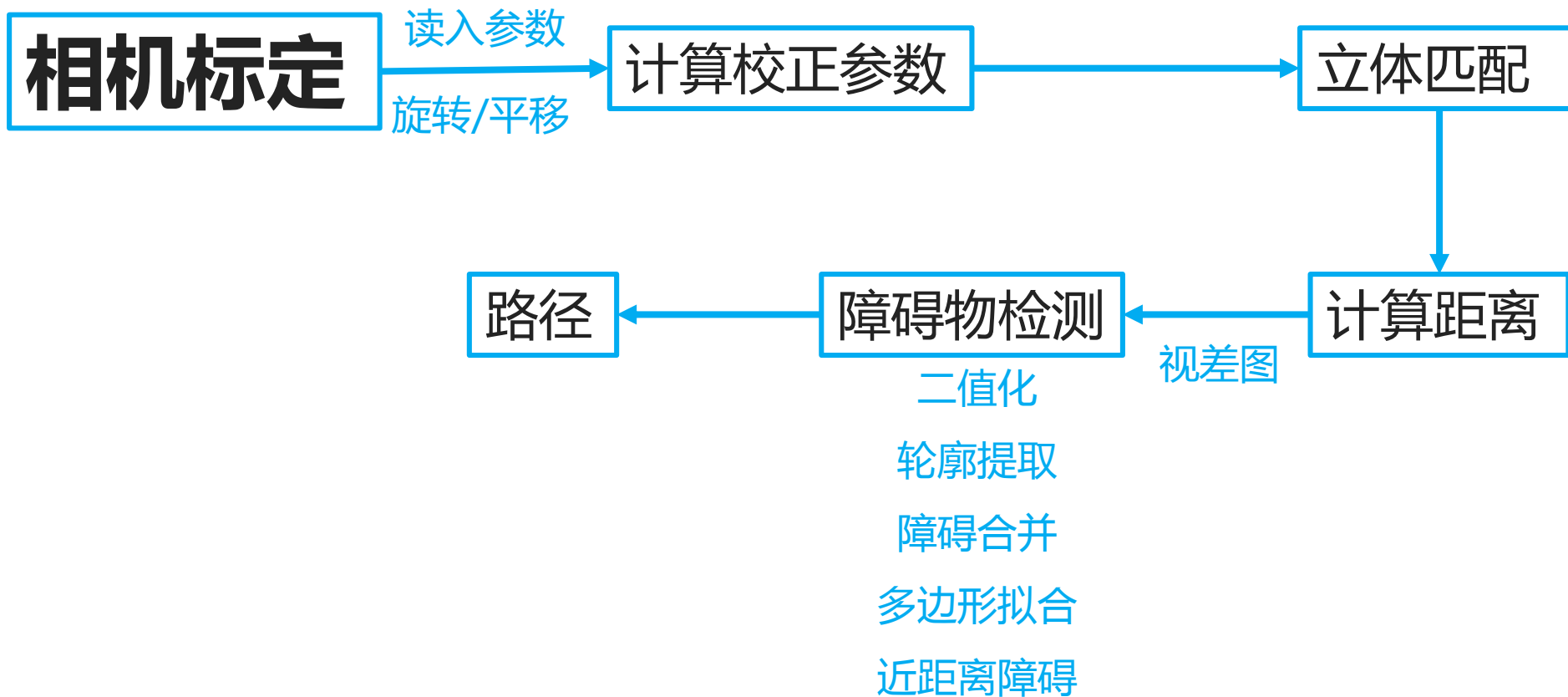
二值化

轮廓提取

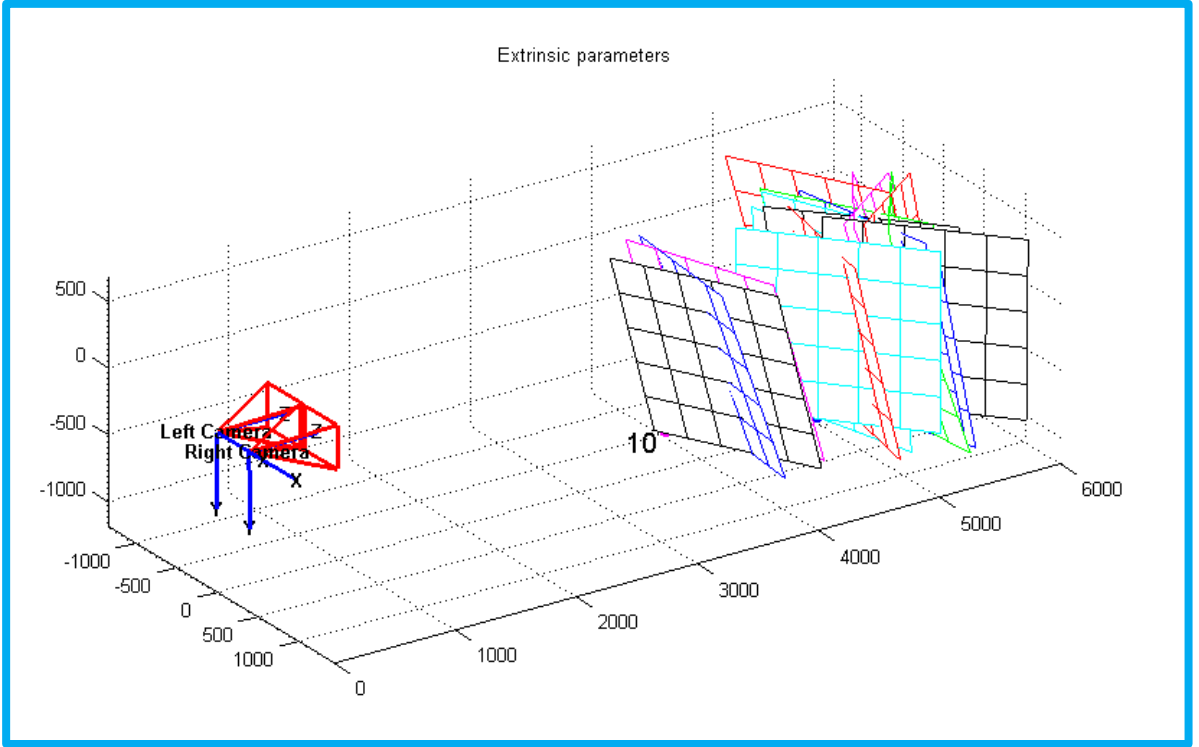
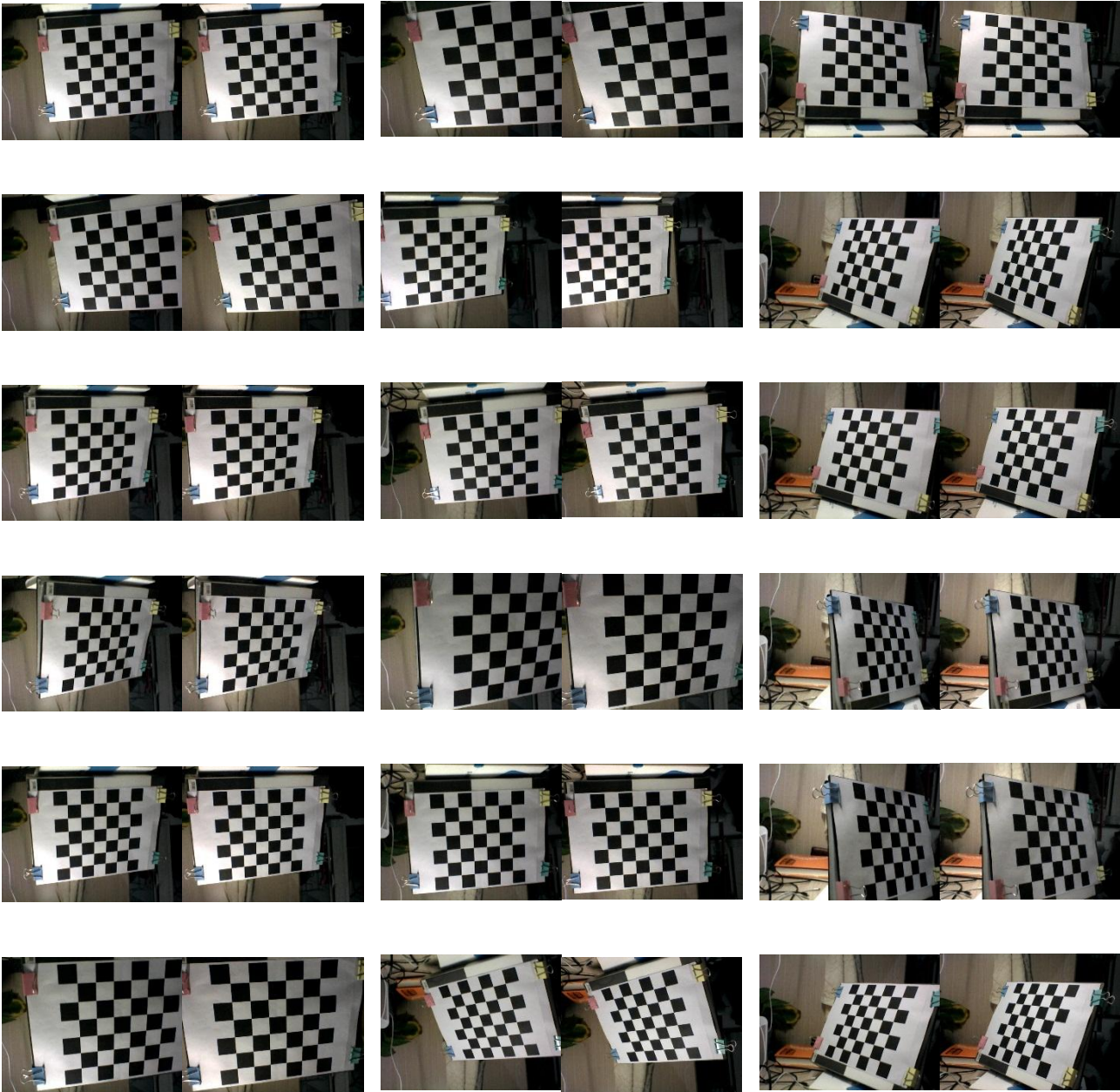
障碍合并

多边形拟合

近距离障碍







Stereo calibration parameters:

Intrinsic parameters of left camera:

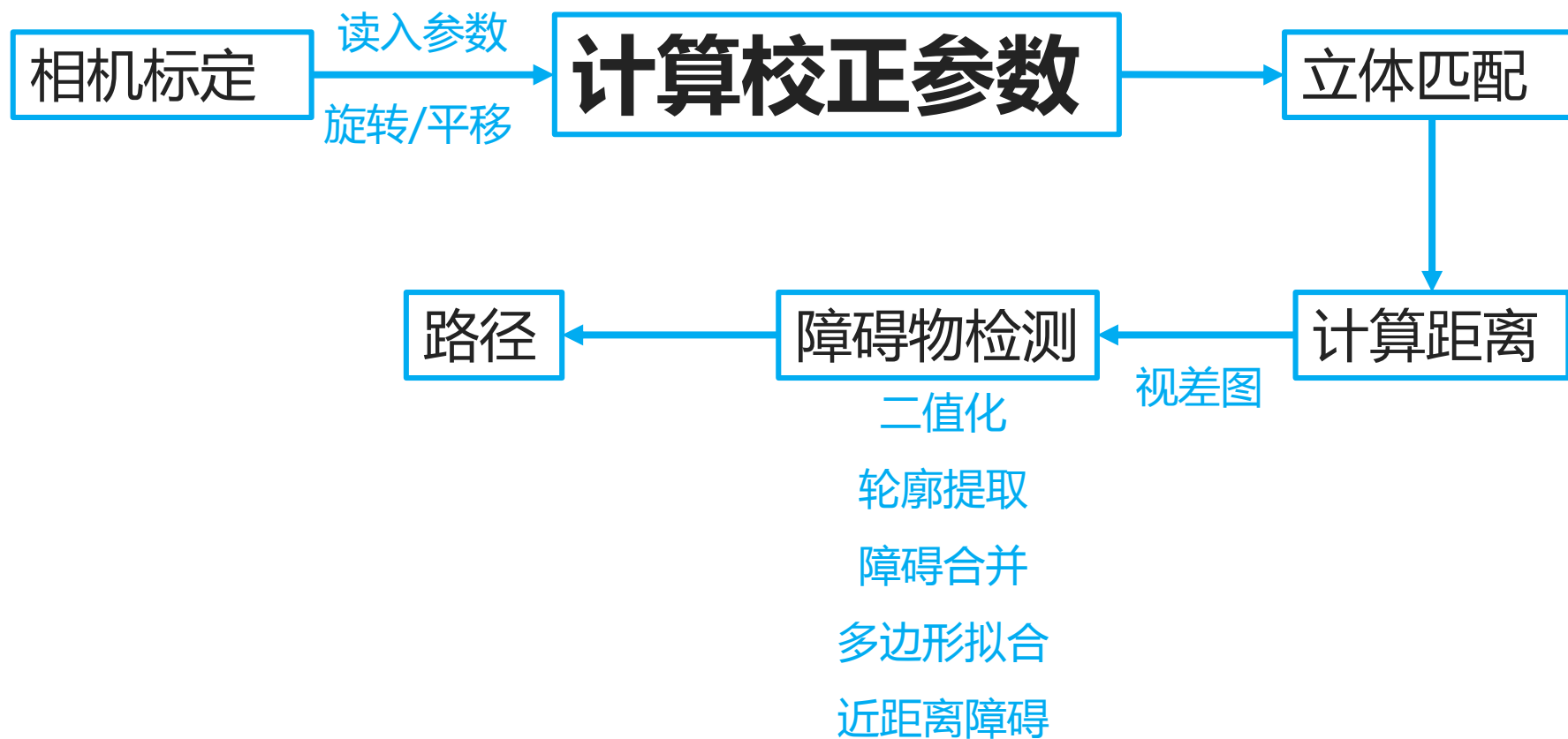
Focal Length:  $fc\_left = [ 820.95127 \quad 825.46409 ] \quad [ 8.32132 \quad 7.50725 ]$   
Principal point:  $cc\_left = [ 327.61428 \quad 201.62853 ] \quad [ 7.08408 \quad 9.99661 ]$   
Skew:  $\alpha\_c\_left = [ 0.00000 \quad 0.00000 ] \Rightarrow \text{angle of pixel axes} = 90.00000 \quad 0.00000 \text{ degrees}$   
Distortion:  $kc\_left = [ -0.02573 \quad -0.23704 \quad -0.02306 \quad 0.00182 \quad 0.00000 ] \quad [ 0.03916 \quad 0.23672 \quad 0.00350 \quad 0.00297 \quad 0.00000 ]$

Intrinsic parameters of right camera:

Focal Length:  $fc\_right = [ 825.64744 \quad 829.73006 ] \quad [ 8.44076 \quad 7.55714 ]$   
Principal point:  $cc\_right = [ 312.95381 \quad 199.12453 ] \quad [ 6.26273 \quad 10.61703 ]$   
Skew:  $\alpha\_c\_right = [ 0.00000 \quad 0.00000 ] \Rightarrow \text{angle of pixel axes} = 90.00000 \quad 0.00000 \text{ degrees}$   
Distortion:  $kc\_right = [ -0.04520 \quad -0.09286 \quad -0.02441 \quad -0.00240 \quad 0.00000 ] \quad [ 0.05416 \quad 0.45039 \quad 0.00374 \quad 0.00278 \quad 0.00000 ]$

Extrinsic parameters (position of right camera wrt left camera):

Rotation vector:  $om = [ -0.00379 \quad 0.01334 \quad -0.00132 ] \quad [ 0.01192 \quad 0.00919 \quad 0.00078 ]$   
Translation vector:  $T = [ -401.11333 \quad 0.60737 \quad 9.02866 ] \quad [ 3.11352 \quad 2.97932 \quad 19.15727 ]$





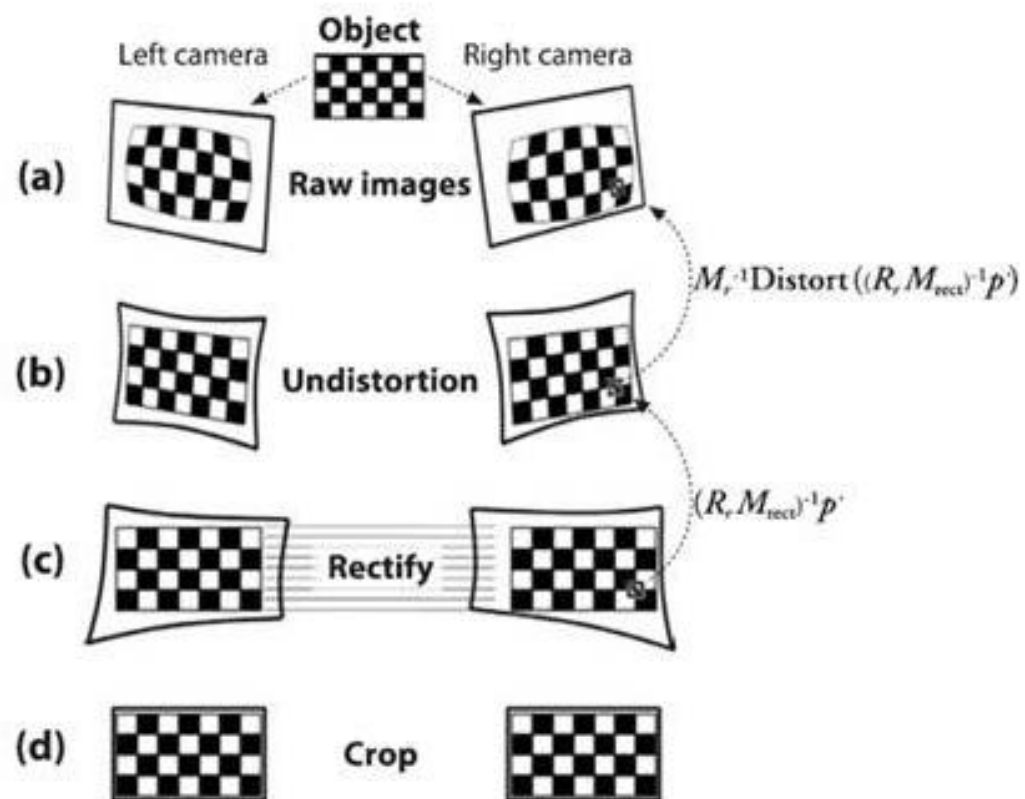
# 双目校正

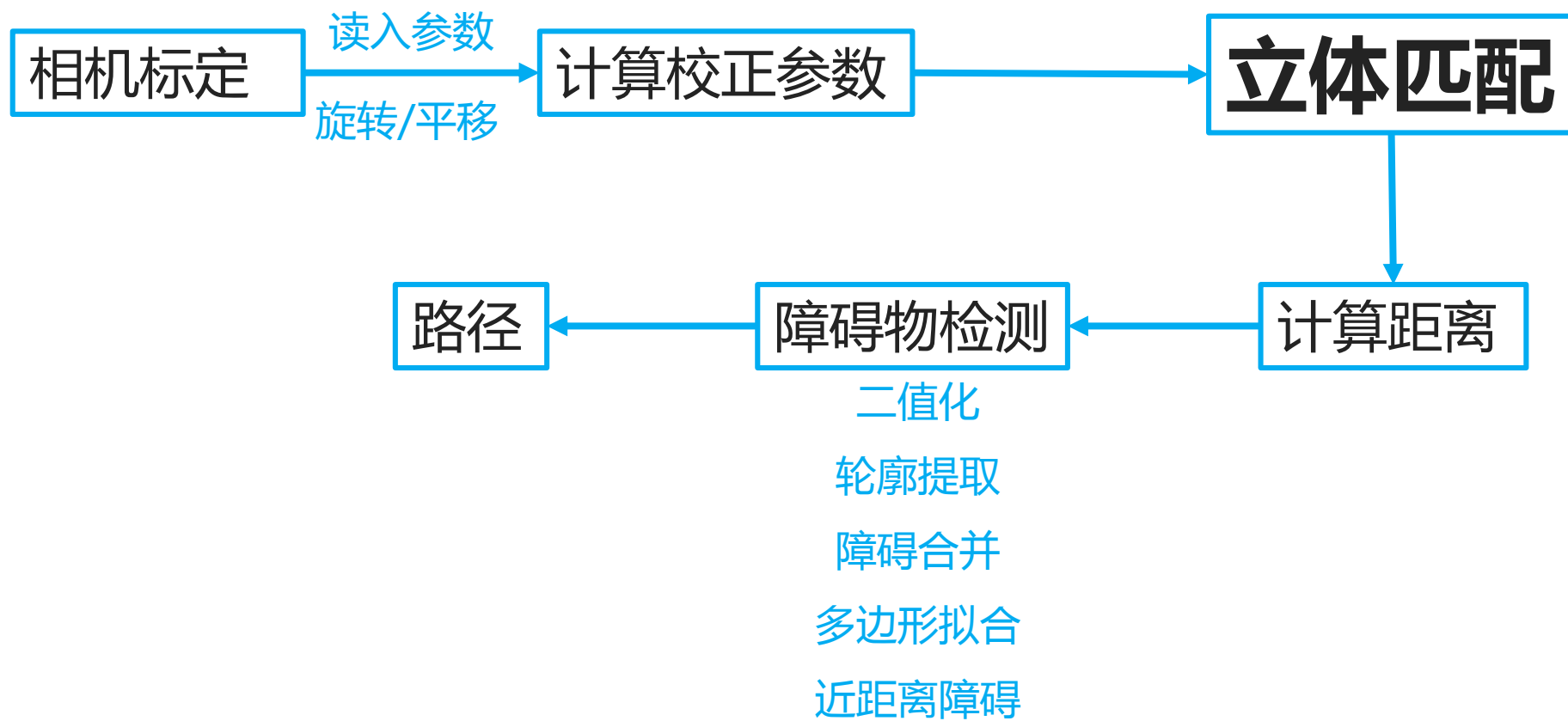
原始视图

消除畸变

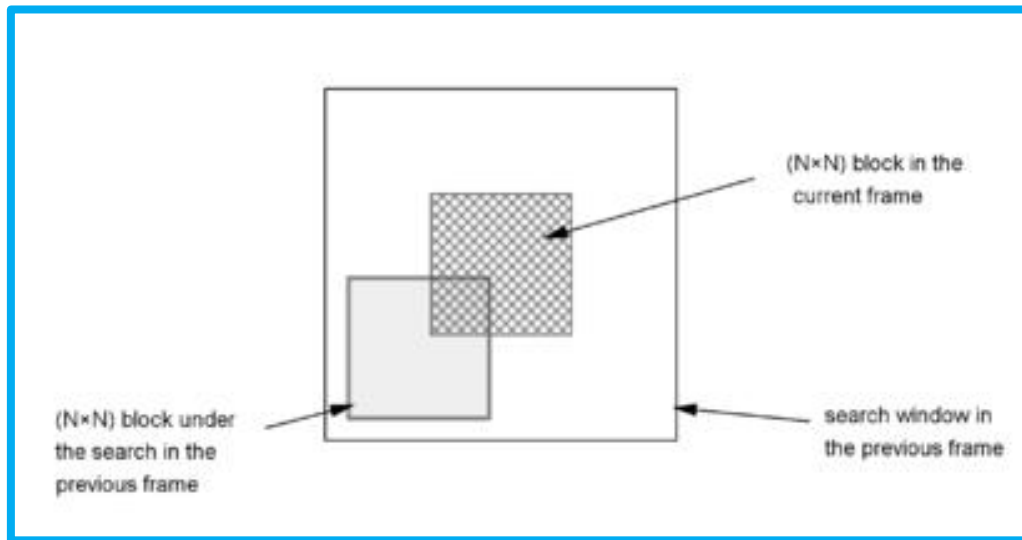
双目校正

图像剪裁





## BM算法(block-matching)



## SGBM算法(semi-globalblock-matching)

## GC算法

效果

时间

差

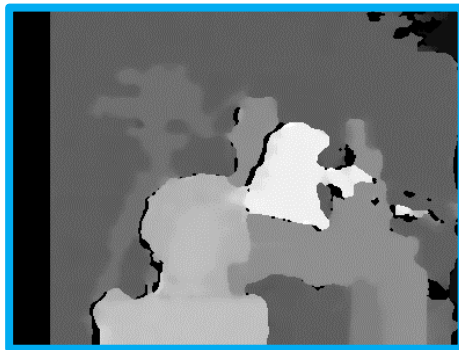
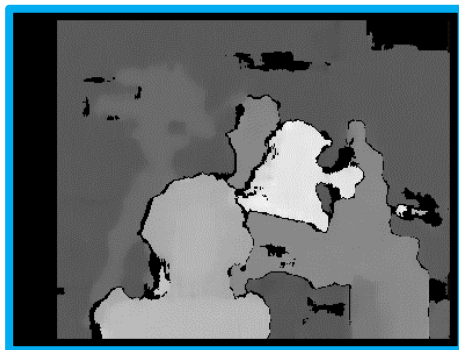
短

中

中

好

长

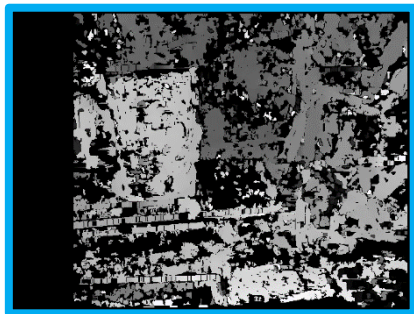




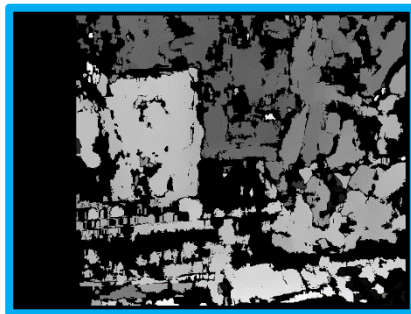
Left



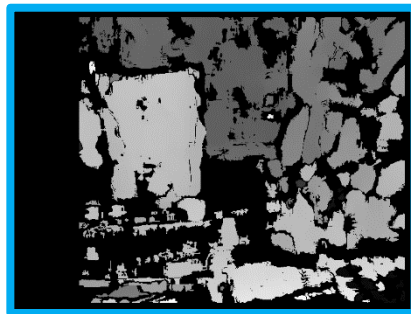
Right



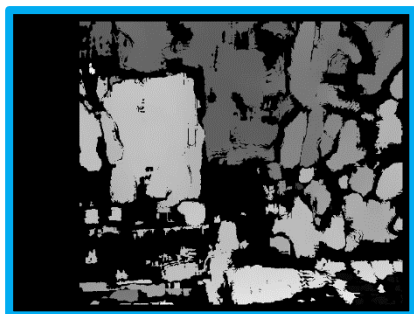
9 96 12



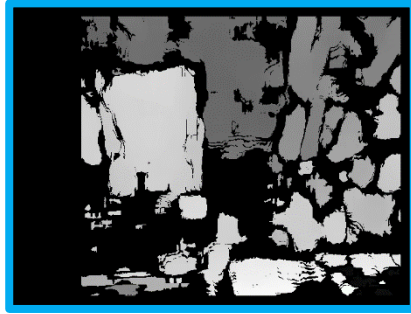
15 96 12



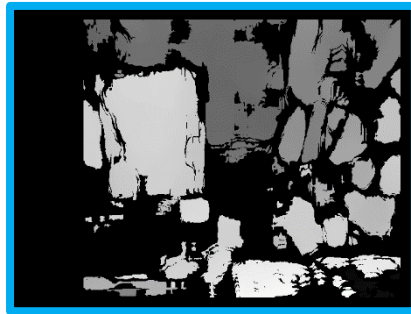
21 96 12



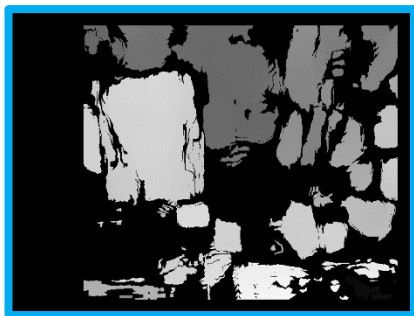
25 96 12



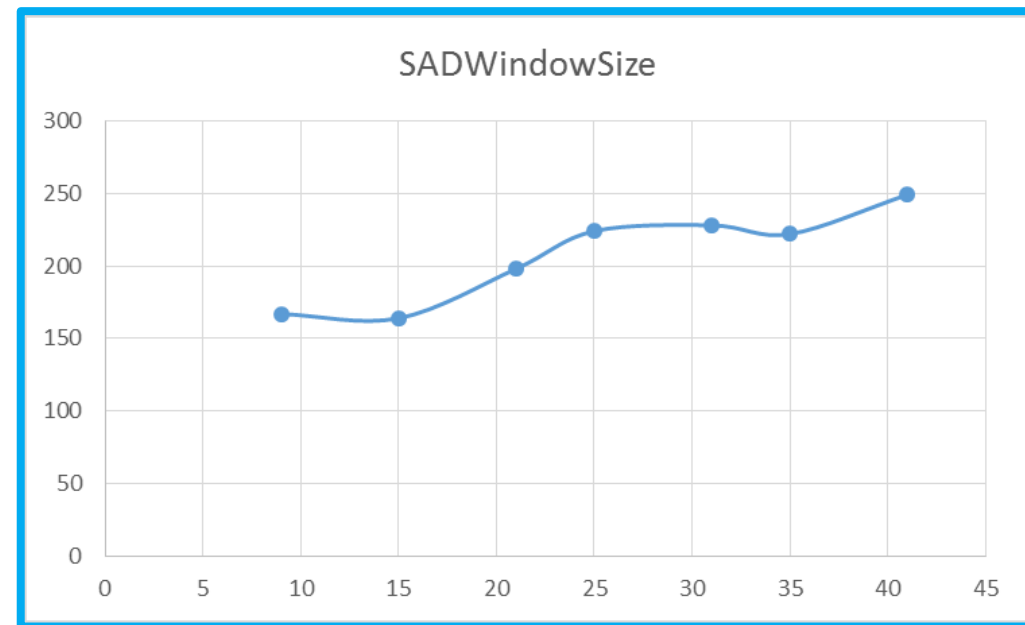
31 96 12



35 96 12



41 96 12







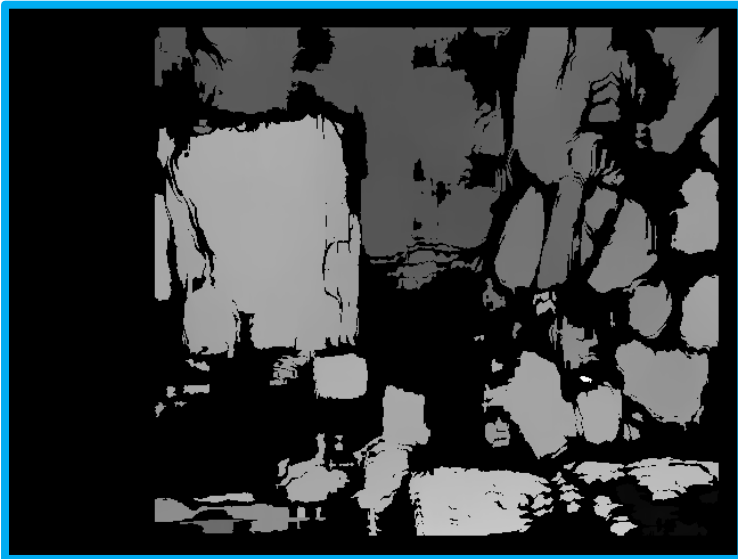
35 64 12



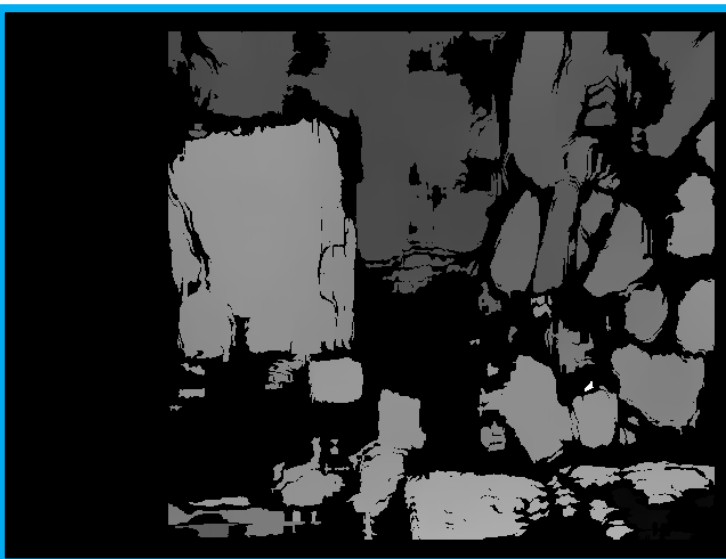
35 80 12



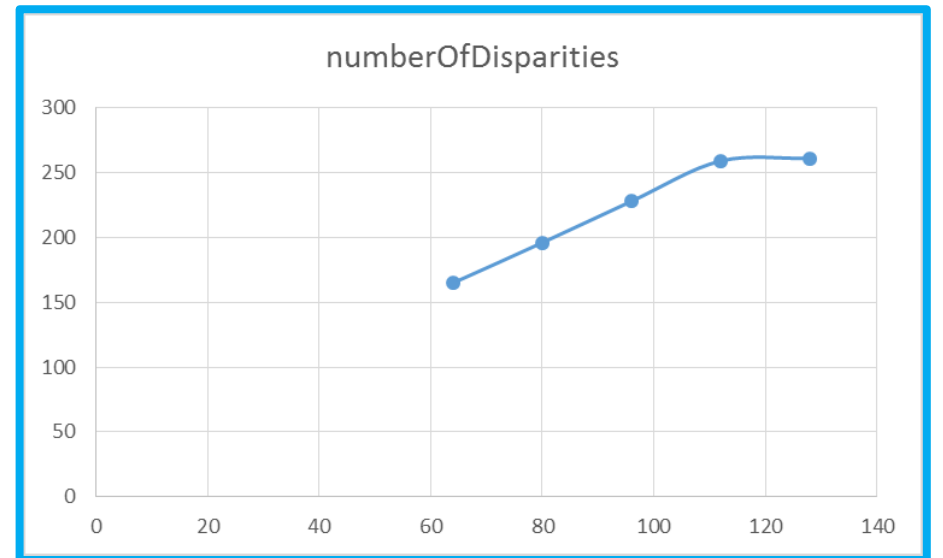
35 96 12



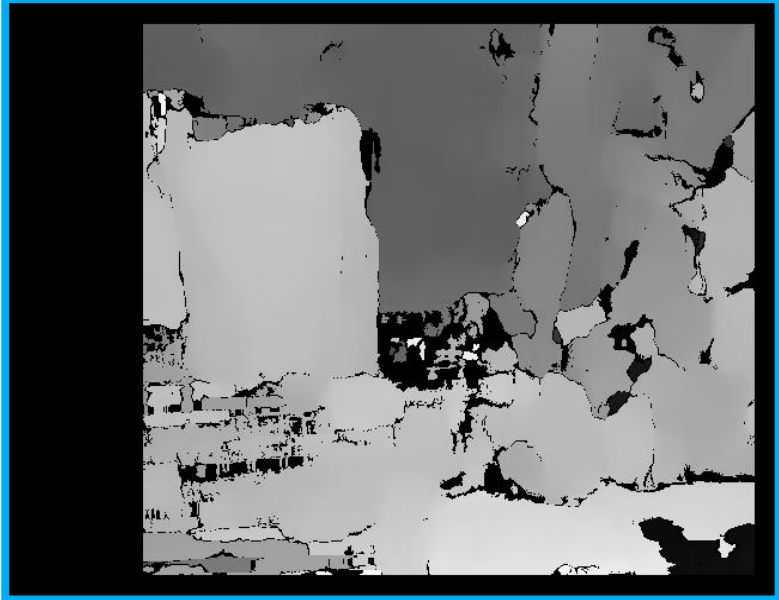
35 112 12



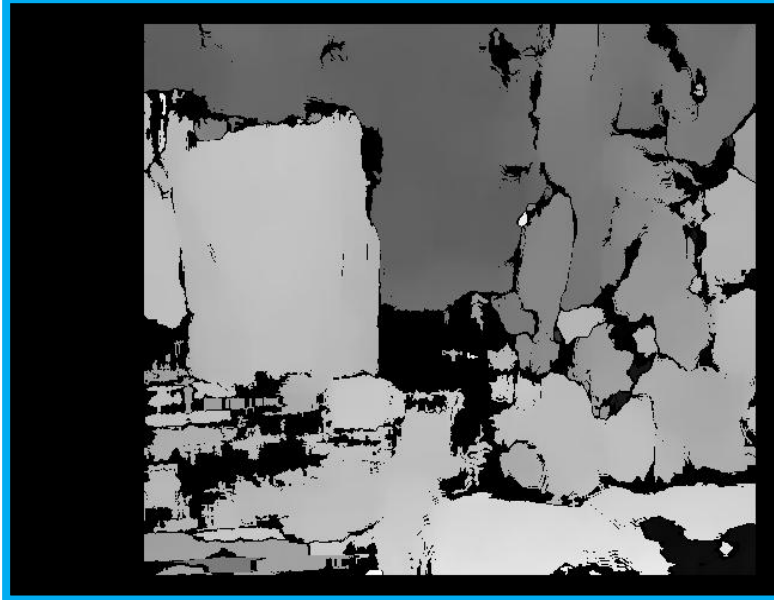
35 128 12



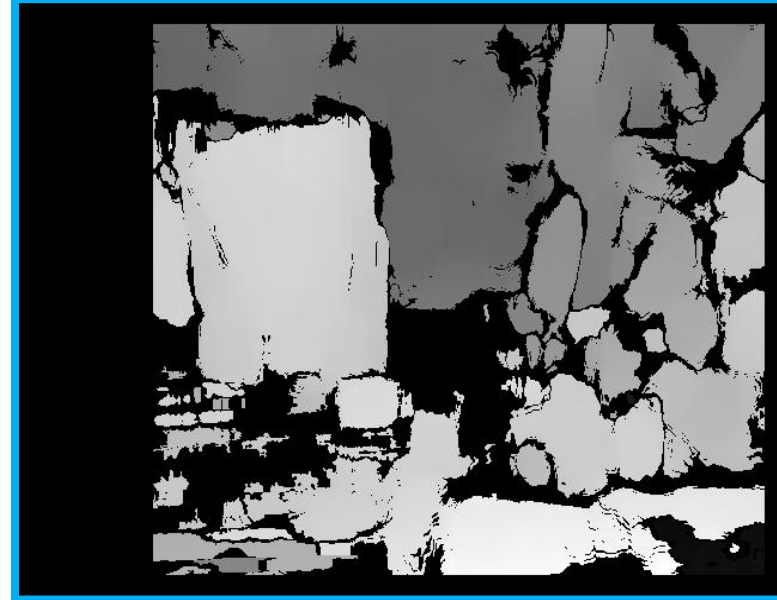
numberOfDisparities



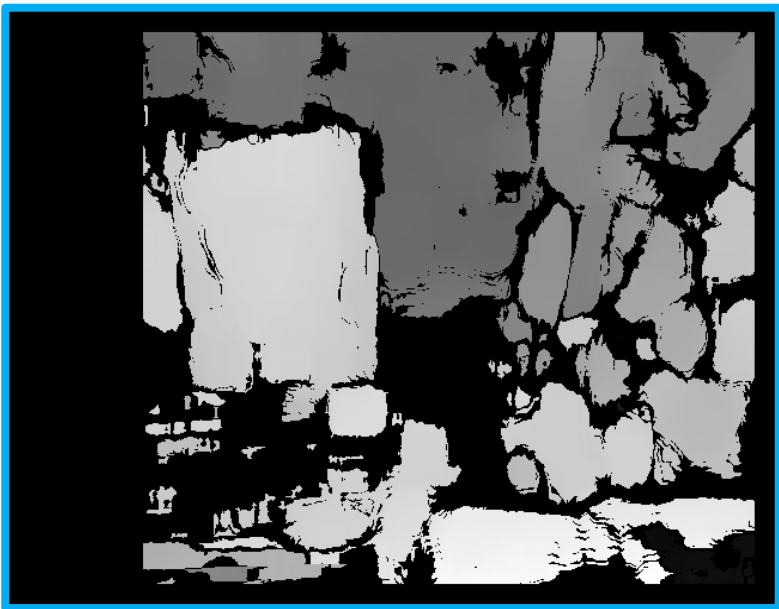
35 96 2



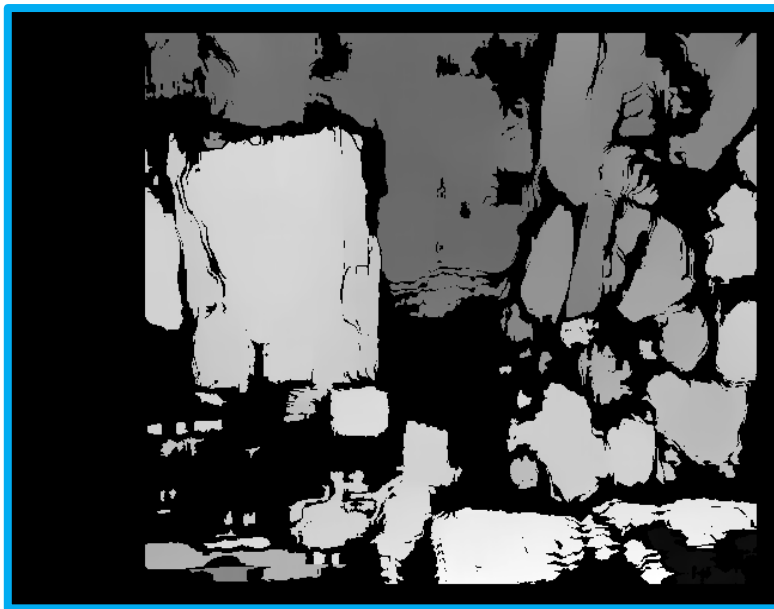
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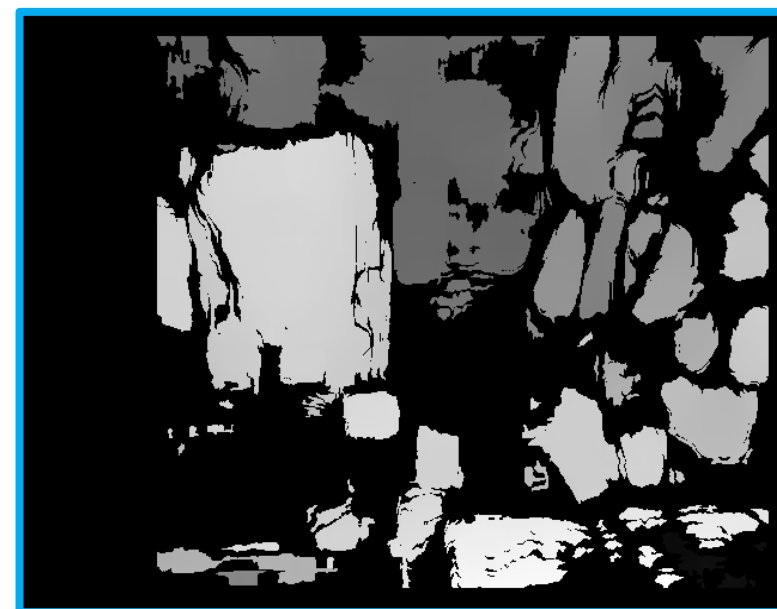
35 96 6



35 96 8

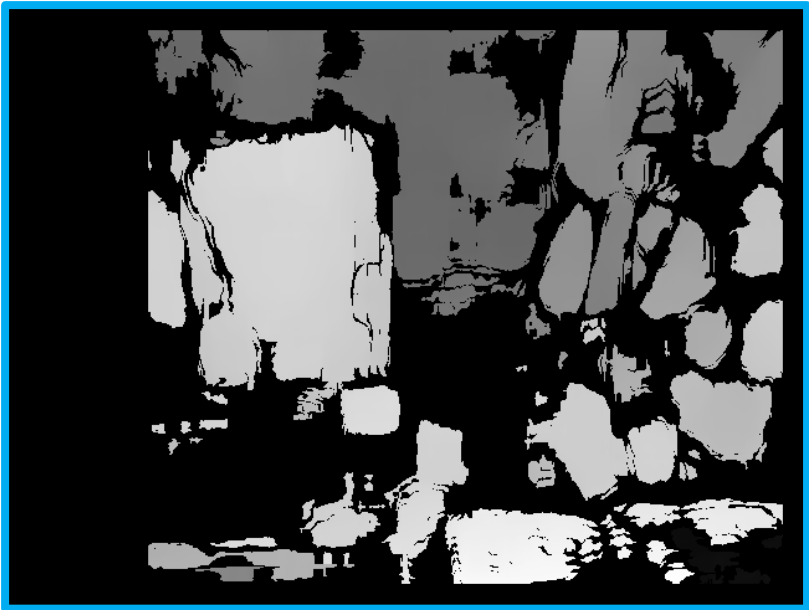


35 96 10

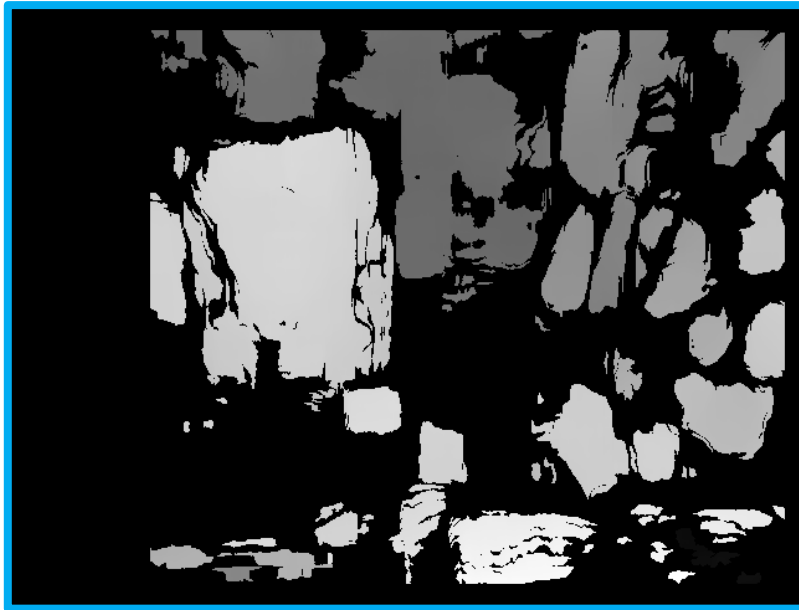


35 96 12

uniquenessRatio



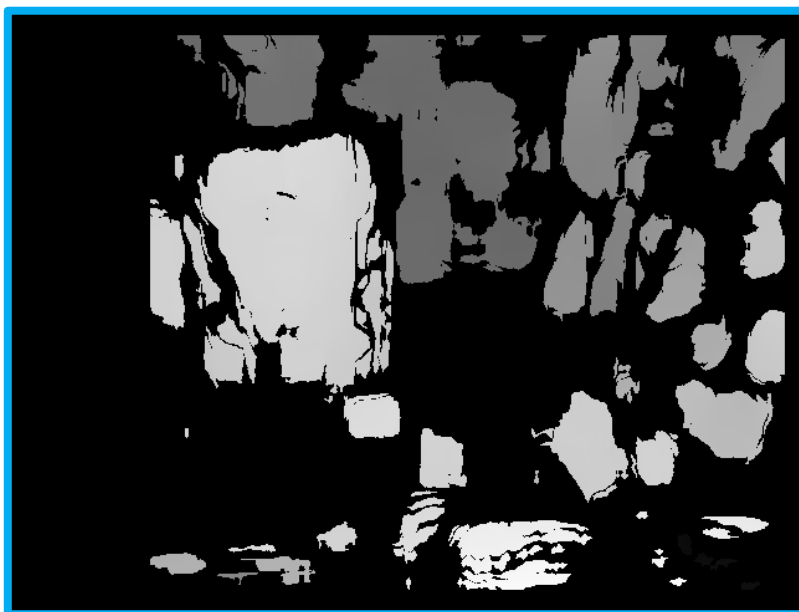
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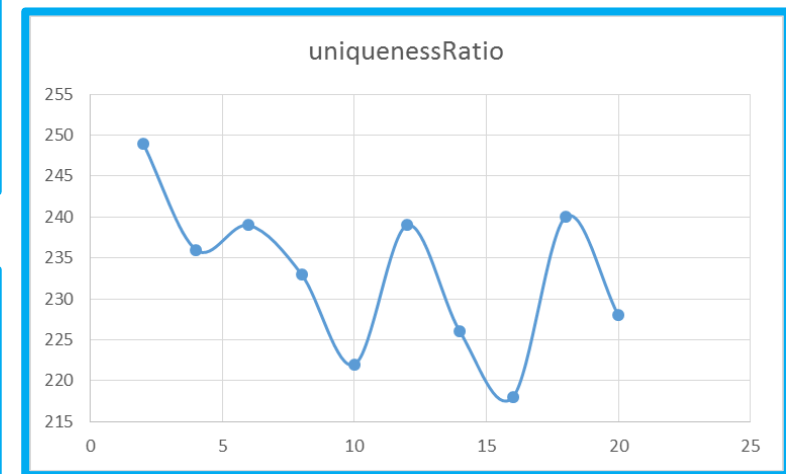
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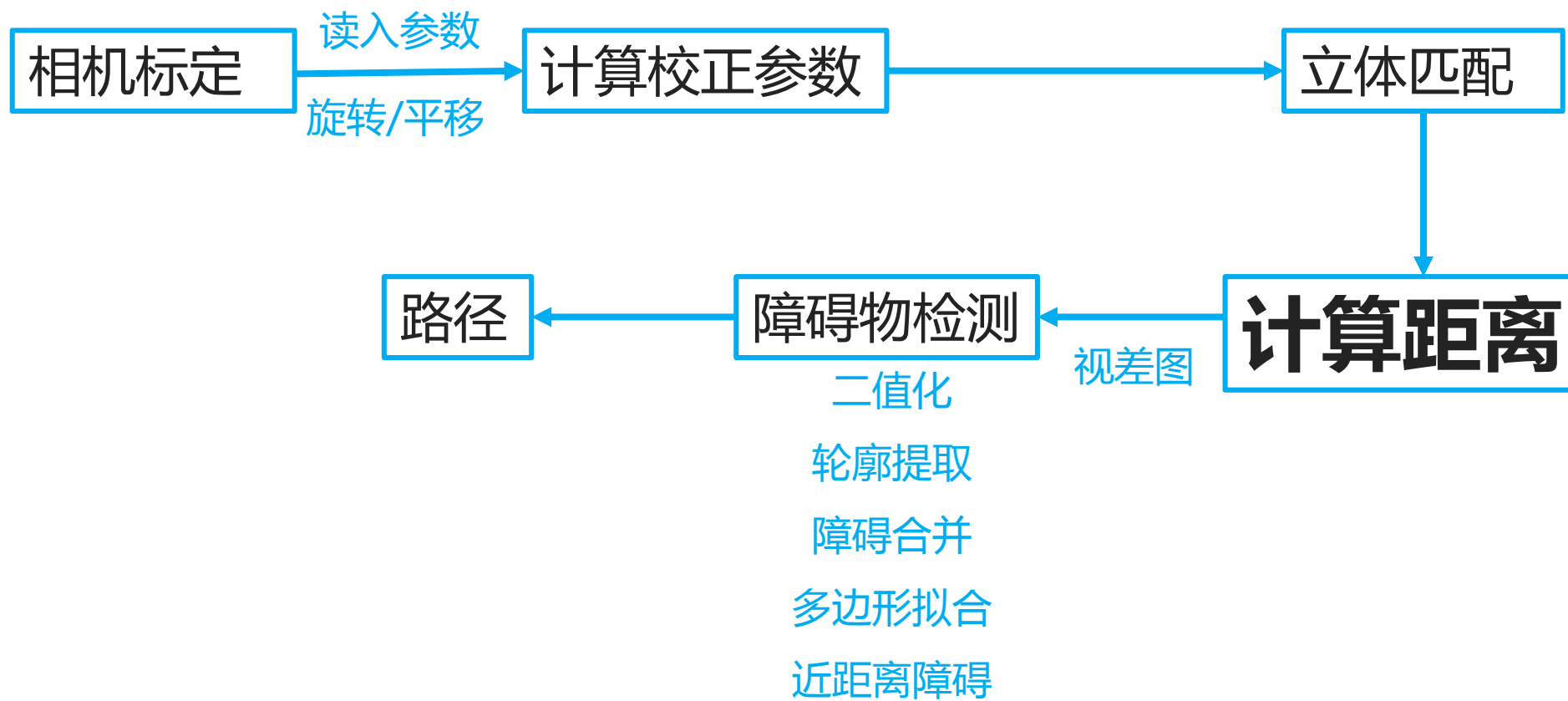
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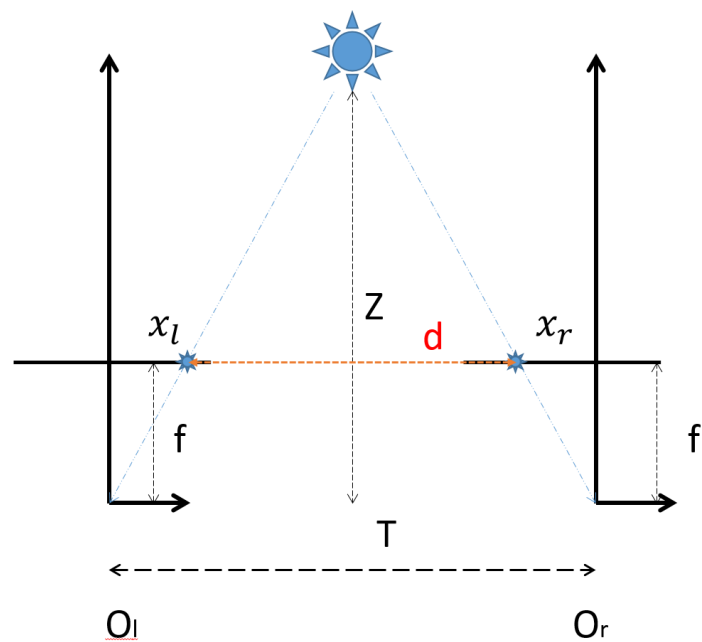
35 96 20



uniquenessRatio



# 测距原理



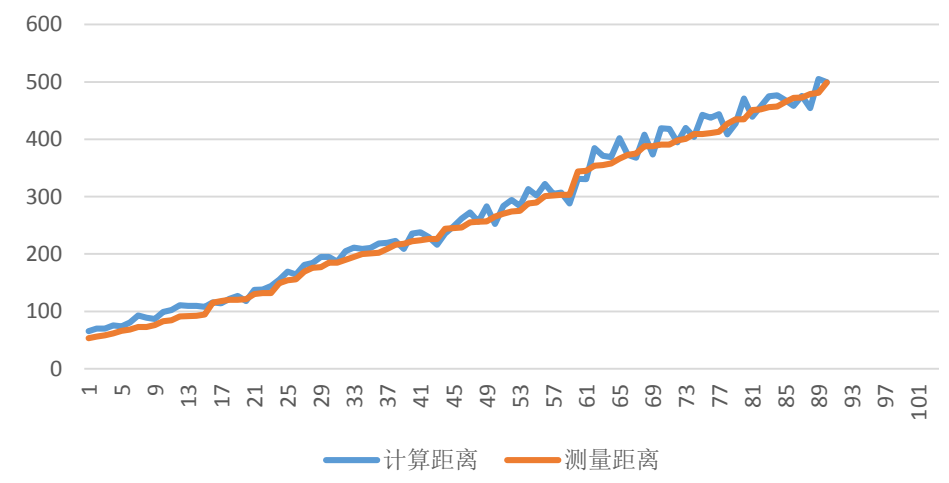
$$d = x_l - x_r$$

$$\frac{T - (x_l - x_r)}{Z - f} = \frac{T}{Z}$$

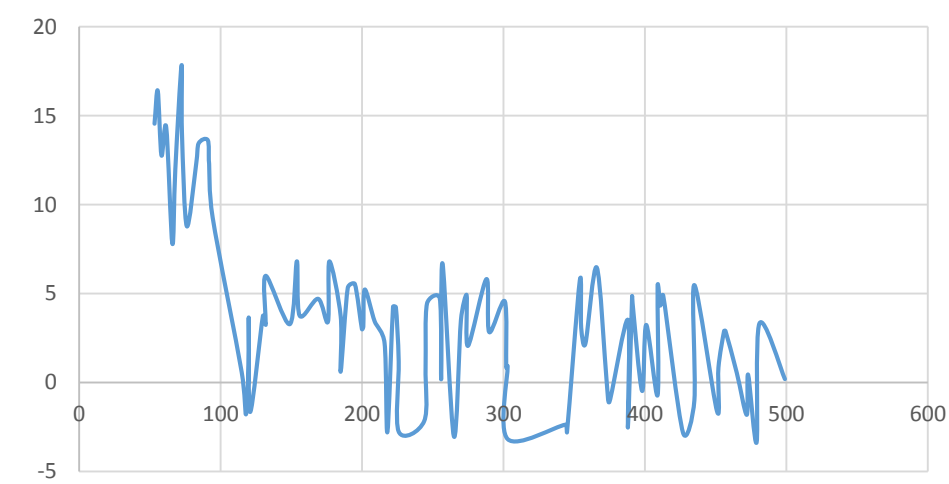
$$Z = \frac{fT}{x_l - x_r}$$

$$Z = \frac{fT}{d}$$

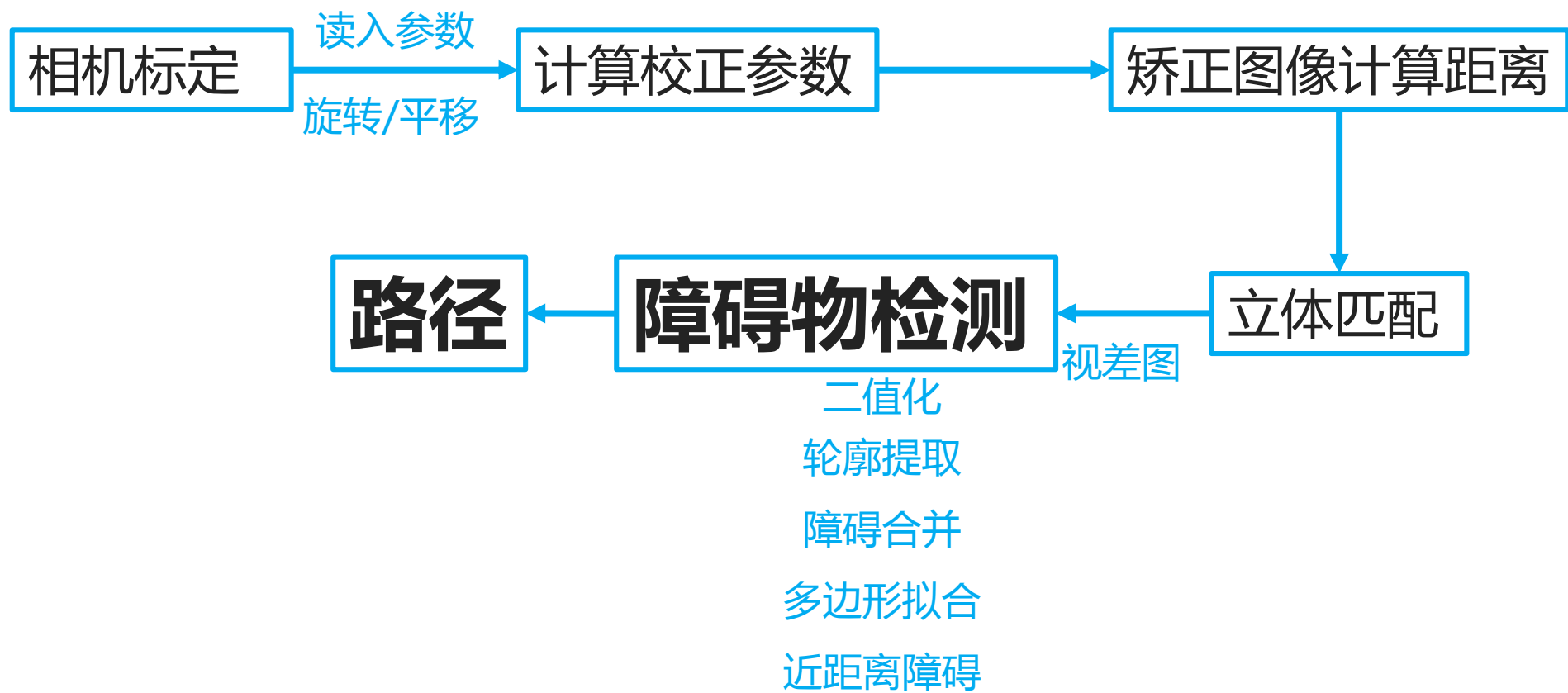
距离测量

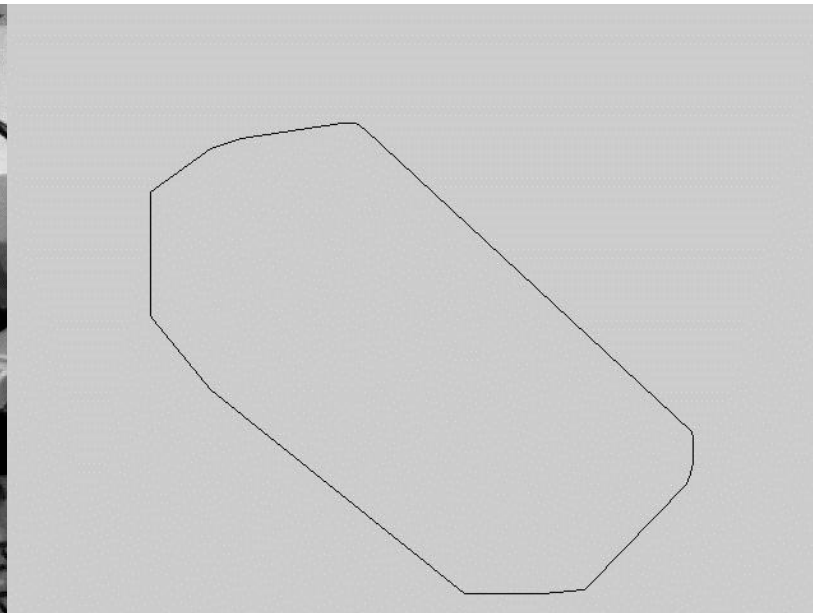


误差百分比









障碍检测结果



+



=



障碍检测结果

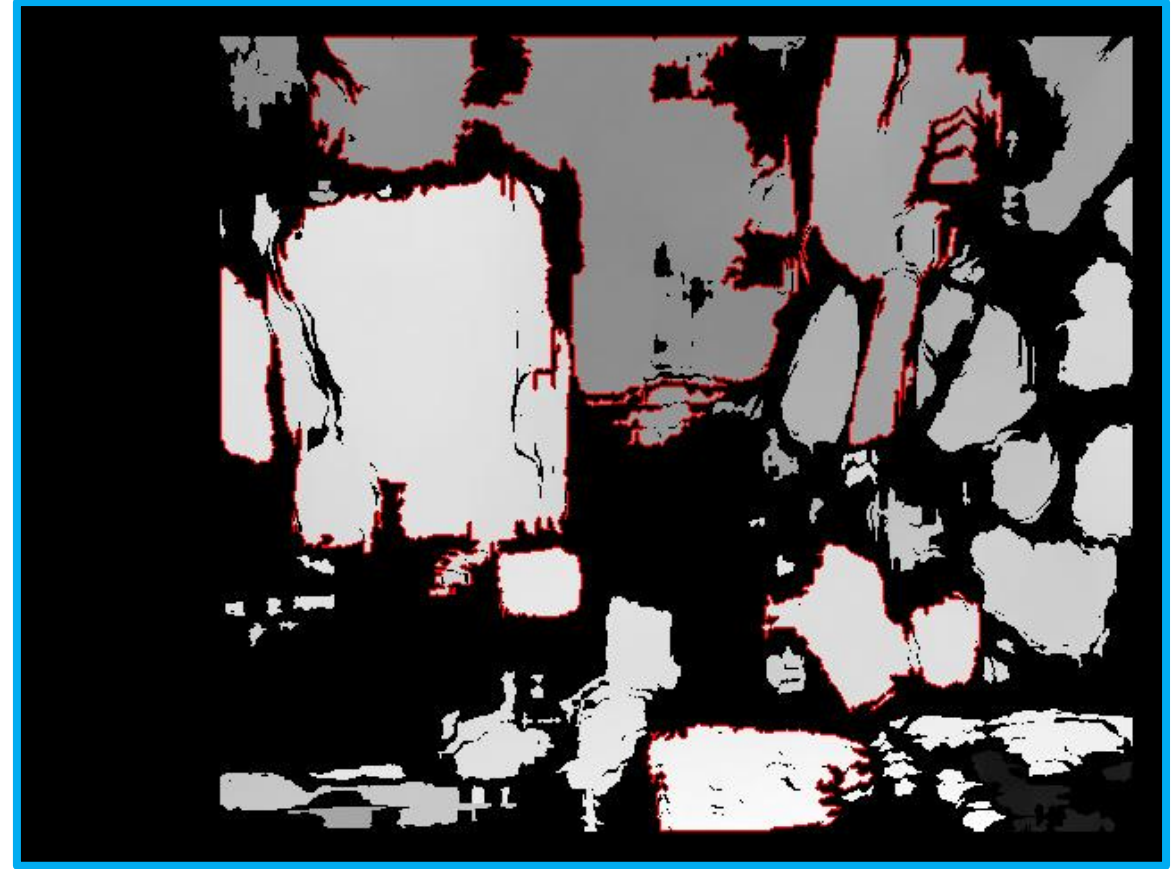




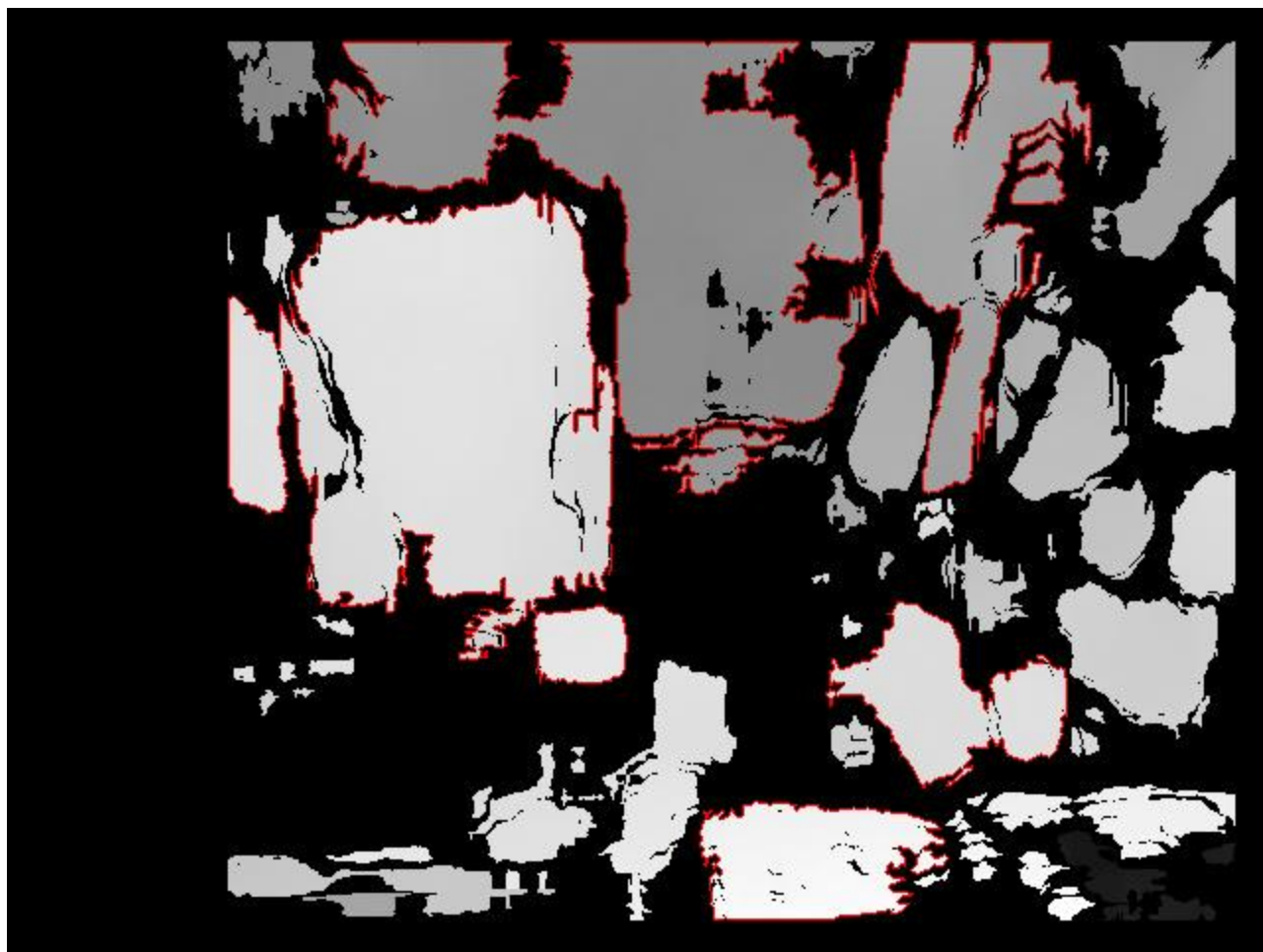
+



=



障碍检测结果



障碍检测结果

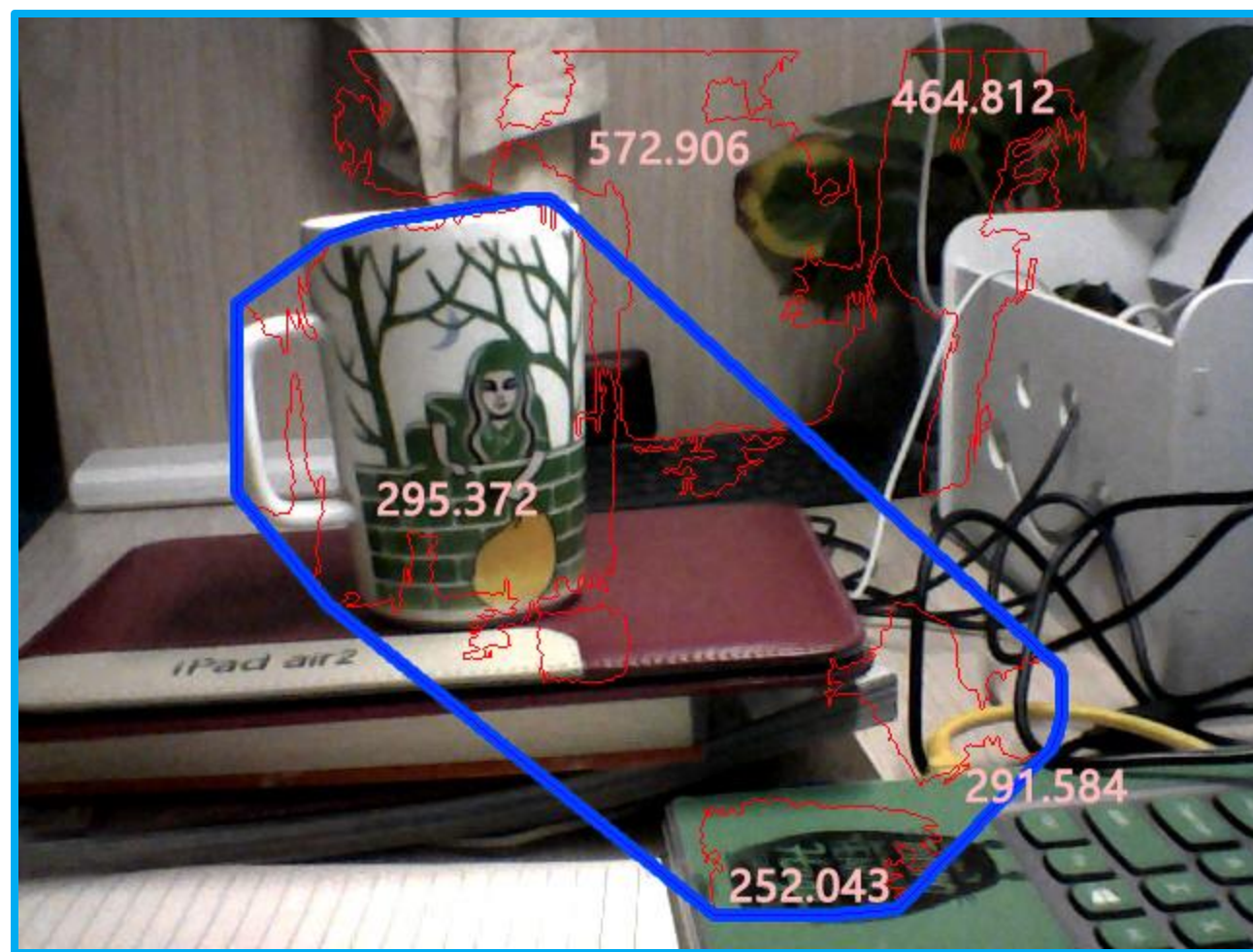




障碍检测结果

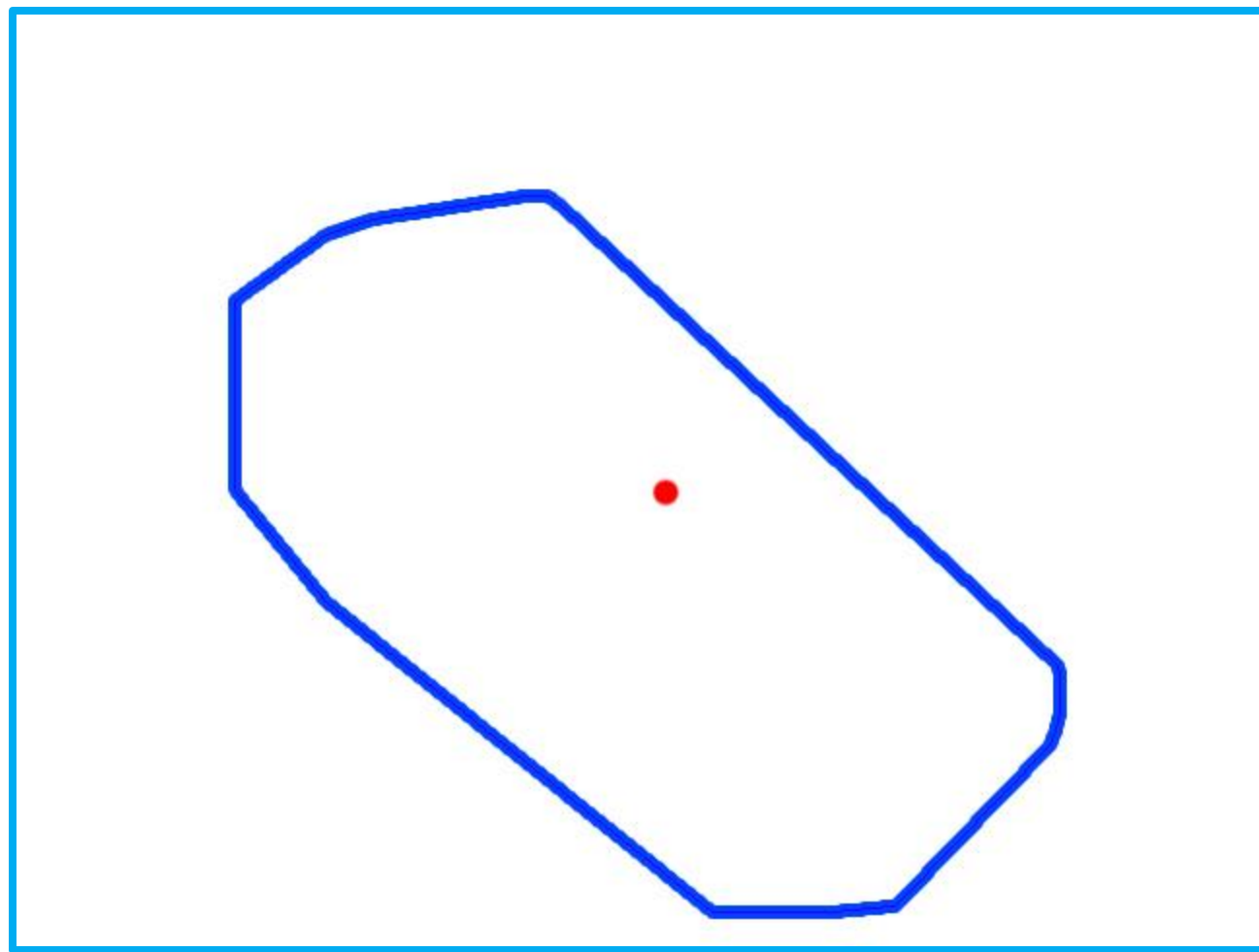


障碍检测结果

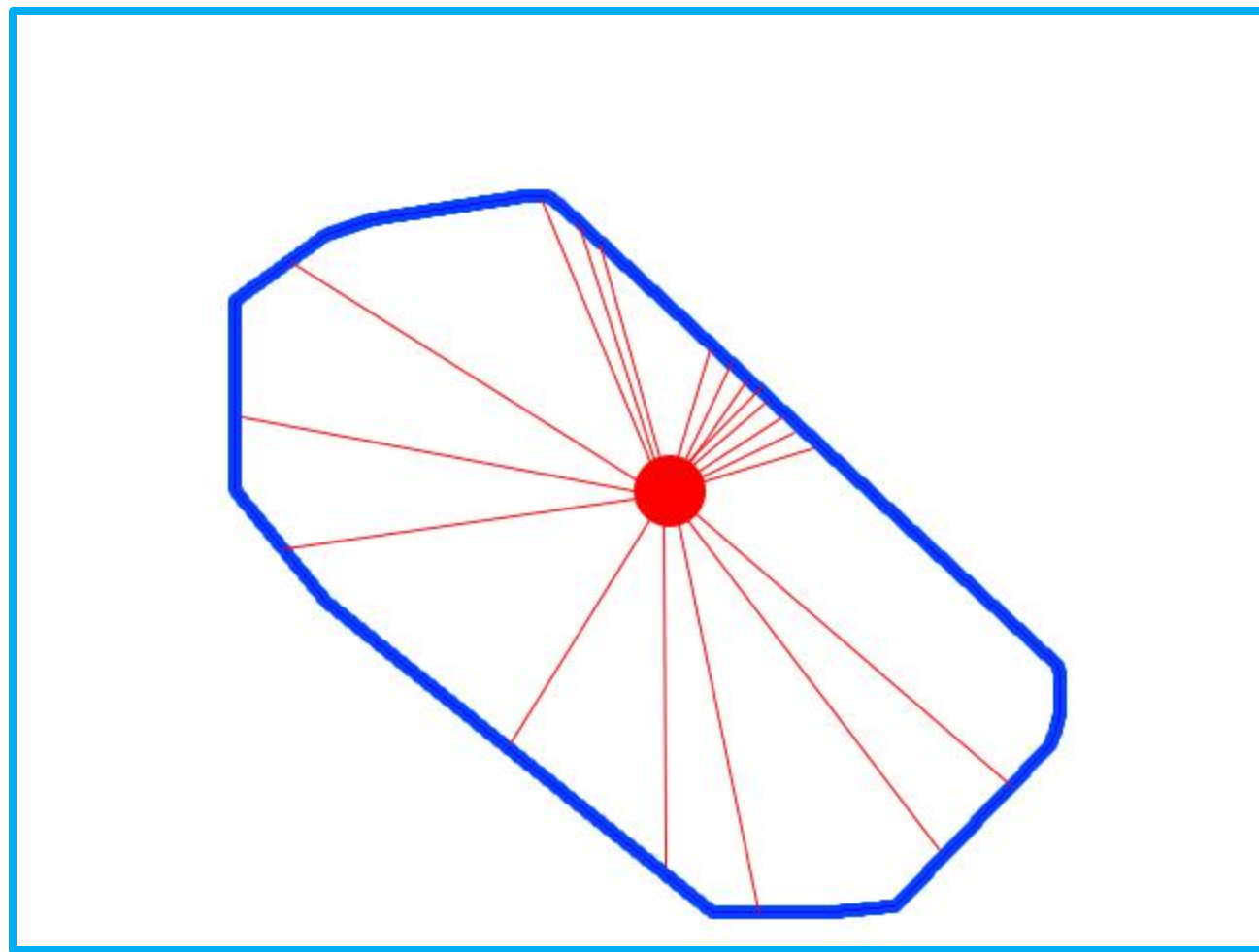


障碍检测结果





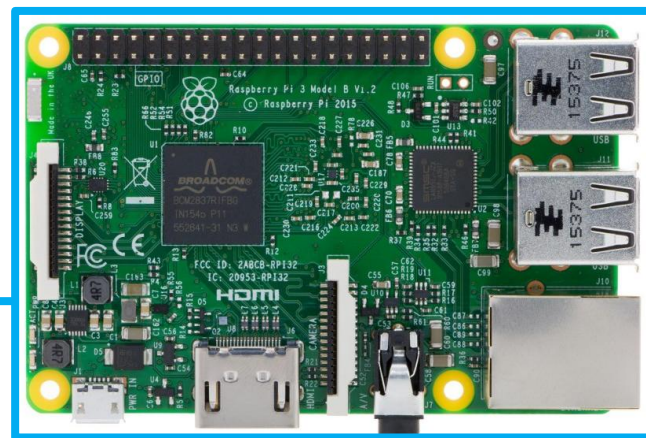
障碍检测结果



障碍检测结果



ARM Cortex-A53



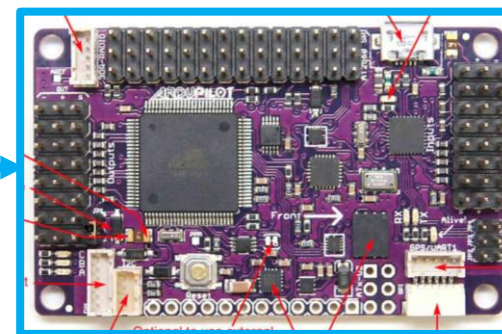
传感器

ARM Cortex-M3



UART

16bit MCU

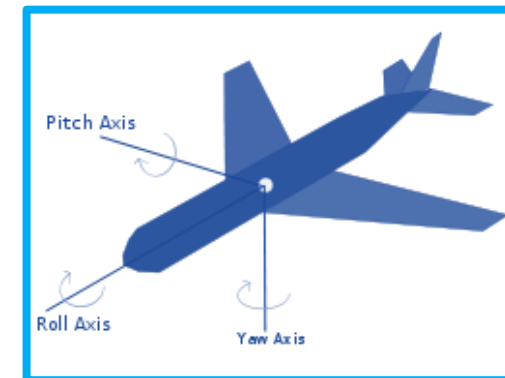
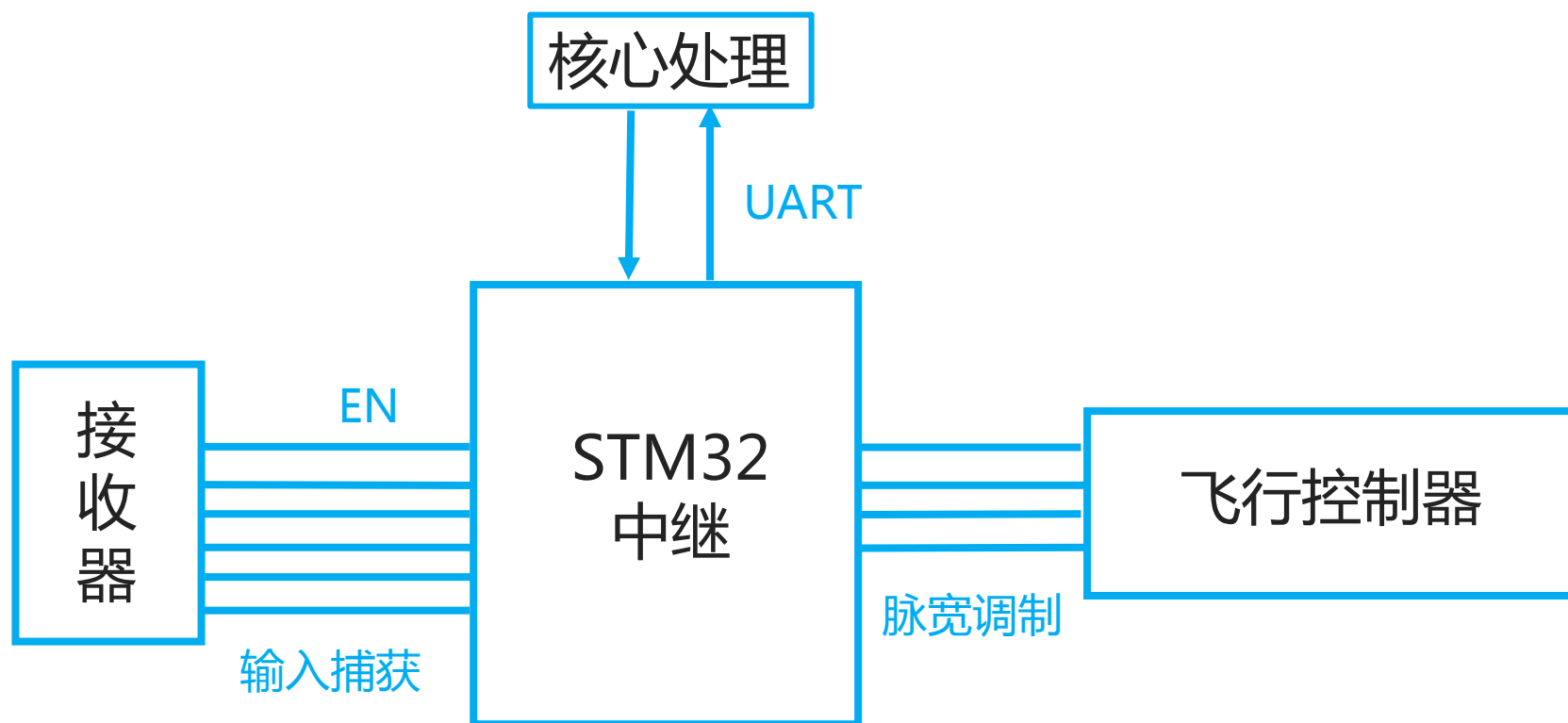


飞行器

2.4G

遥控器

接收器



# 总结和不足

- 1、未重视视硬件系统的调试，四旋翼重心不稳，机臂较软，稳定性不足，无法完成定点飞行，导致系统无法上机调试和进行参数调整。
- 2、即使选用精确度最低的算法，依然需要仅500ms/张的处理速度，对系统的实现造成一定困难。



# 感谢各位老师