

# **Obtaining 3D structure of ceiling by rotating 2D LRF**

Calibrate rotary axis

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# Introduction – Why ceiling?



Fixed object

Beyond the working range

*the idea room*

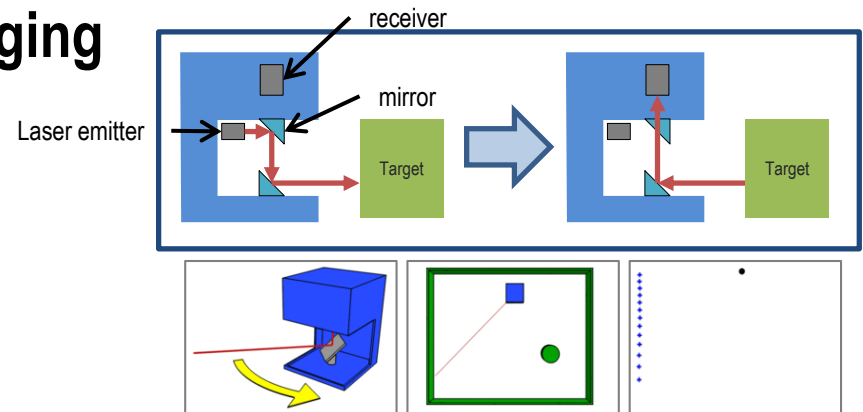
# 3D structure acquisition sensors

Sensors	Pros		Cons	
Stereo vision	Color info. Low cost Dense data	No movement necessary	High complexity Illumination/shade	Align problem
Mono vision				Temporal issue
ToF Camera	High precision	Fast acquisition	Expensive low resolution & working distance	
Radar	Low cost, large working distance		Low resolution & precision	
2D LiDAR	High precision Large working dist.	Moderate cost	Movement necessary	
3D LiDAR		No movement necessary	Expensive	

# 2D Laser range finder vs. 3D LRF

## LiDAR : Light Detection And Ranging

- Laser : High directivity  
→ High accurate
- Measure ToF(time of flight)



## 2D LRF

- Single-Line scan



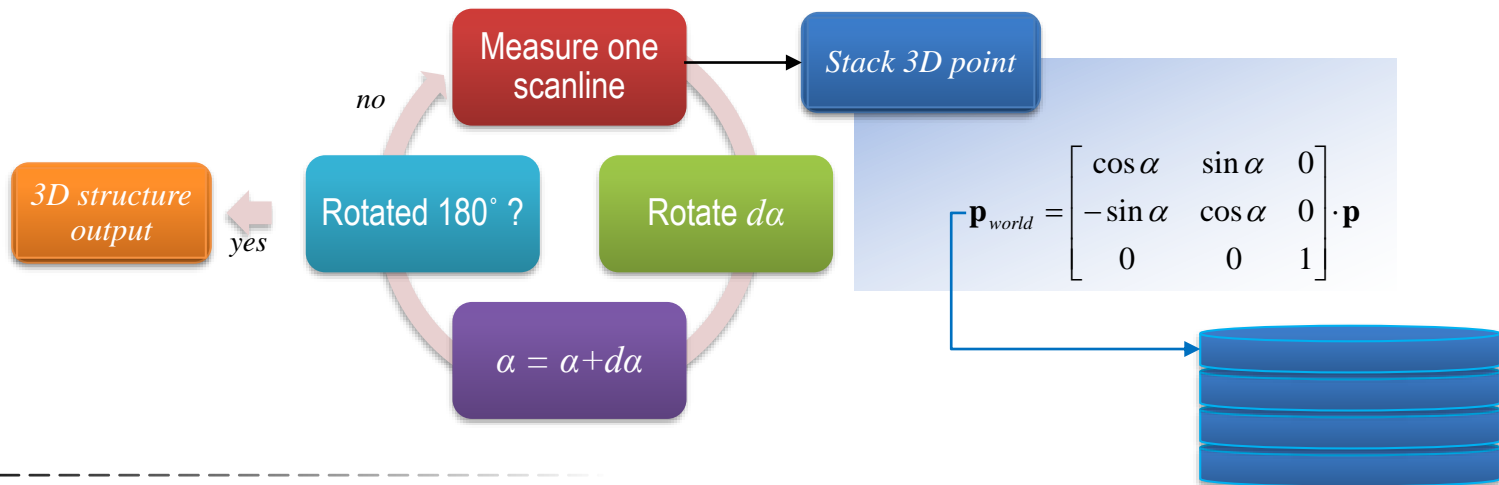
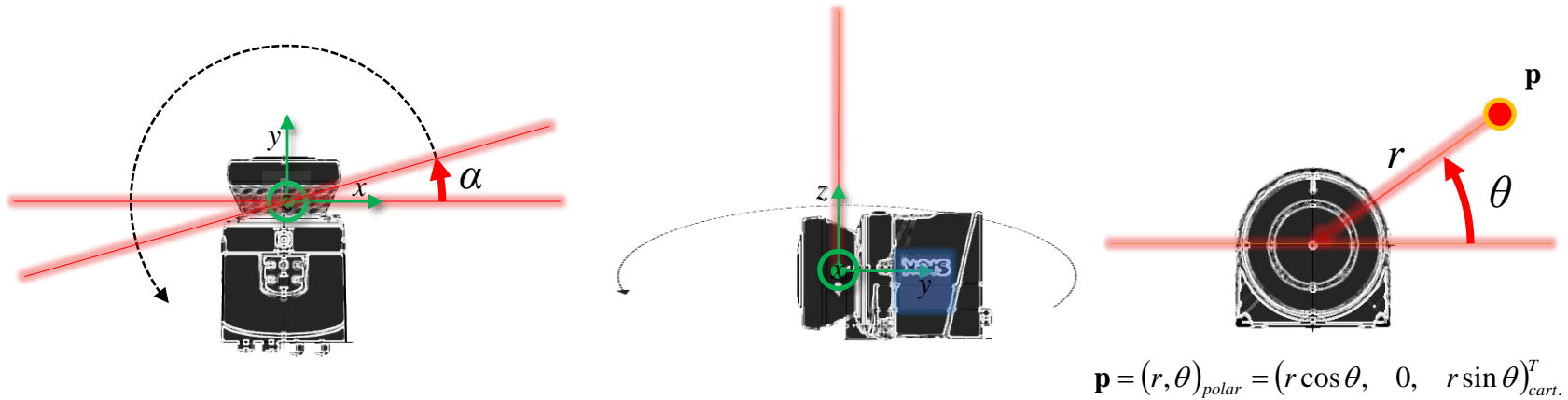
## 3D LRF

- Multiple line scan



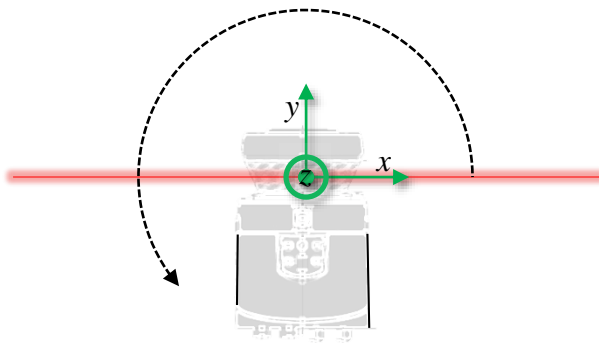
# 3D Scan of ceiling using 2D LRF

- 360 degree Rotation fixing z axis

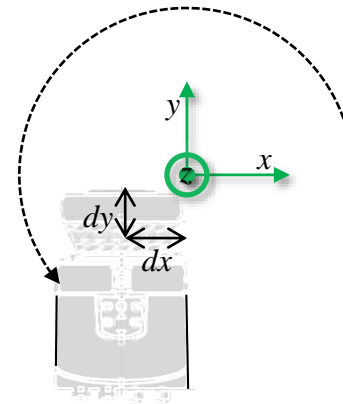


# Rotary Calibration Problem

Ideal  
situation



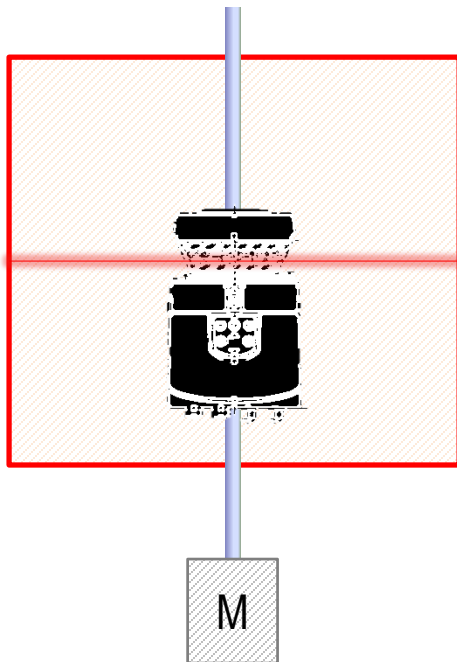
Real  
situation



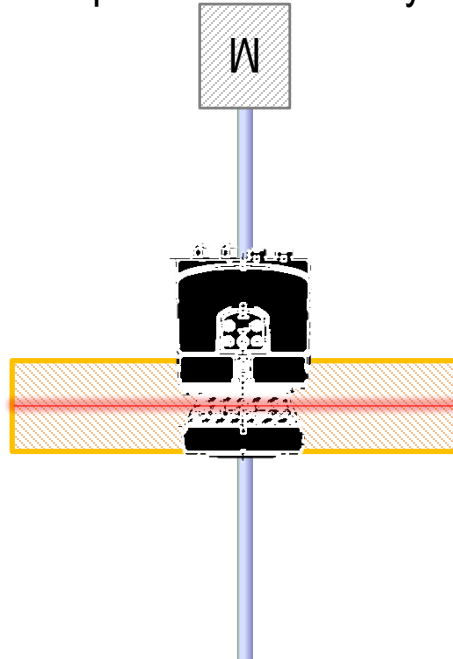
Rotary calibration : to make  $dx$  and  $dy$  zero  
 $dx$  can be measured easily by human eyes  
but  $dy$ ...?

# Proposed rotary axis calibration method

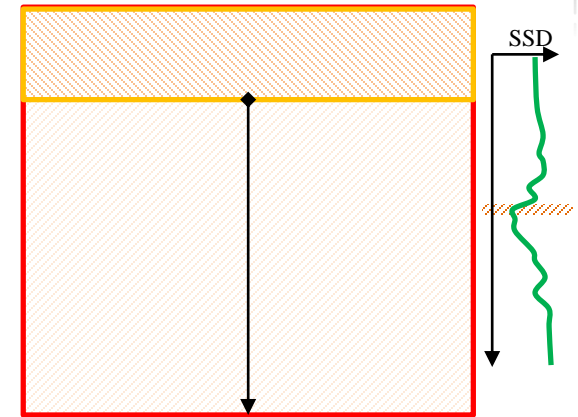
Step 1 : scan widely



Step 2 : scan narrowly



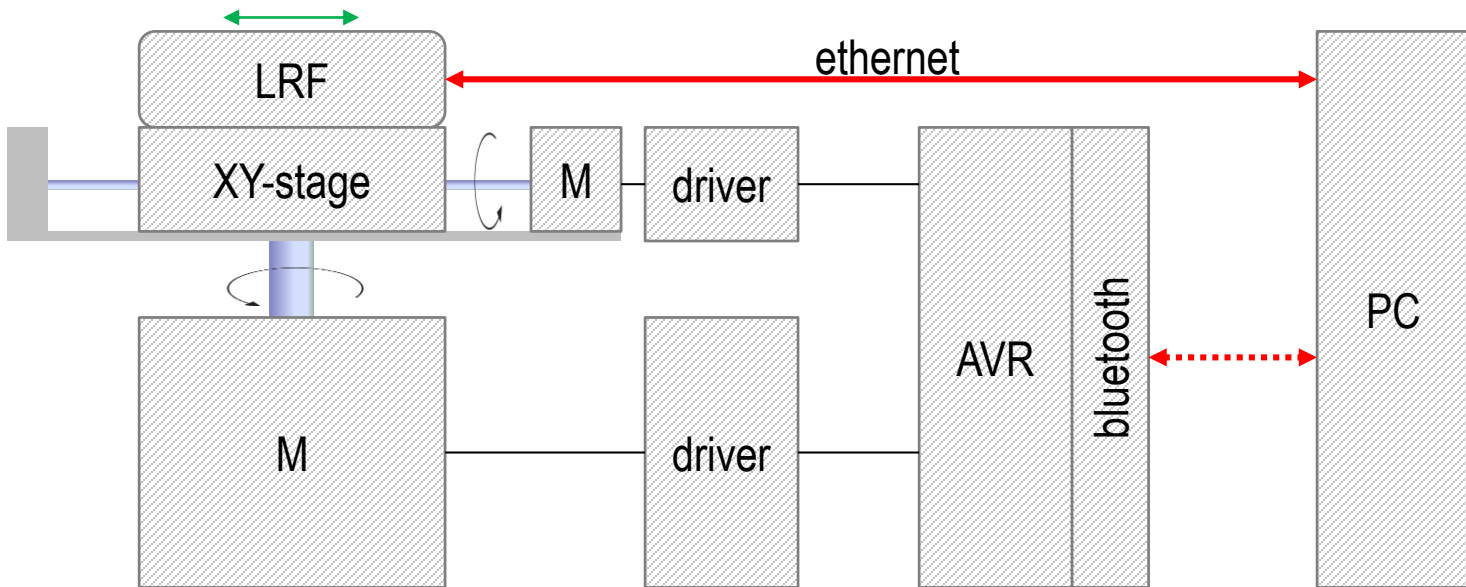
Step 3 : Minimizing SSD



Step 4 : iterate until stable

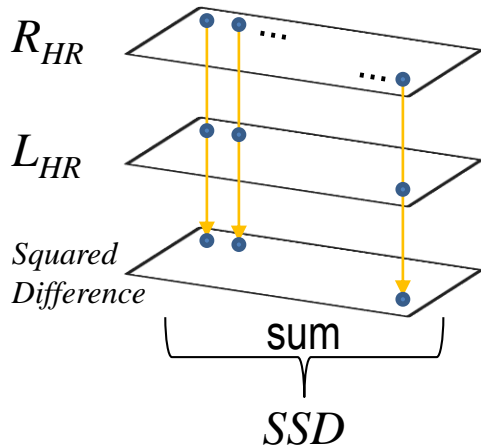


# Hardware System overview

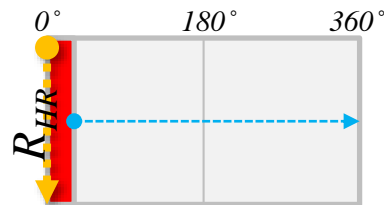
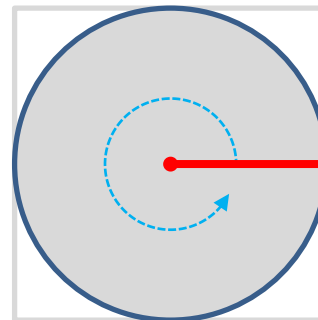
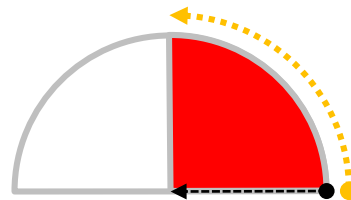


# Performance evaluation method

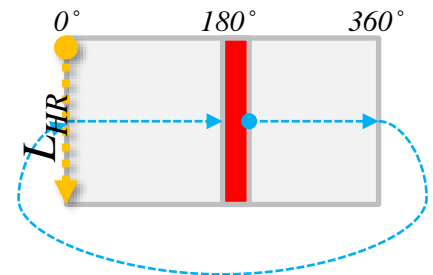
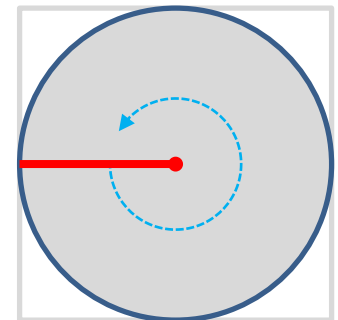
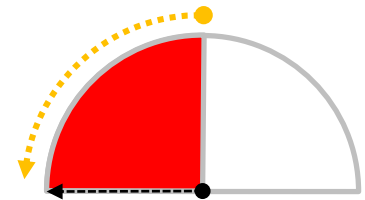
- Half & half matching using SSD



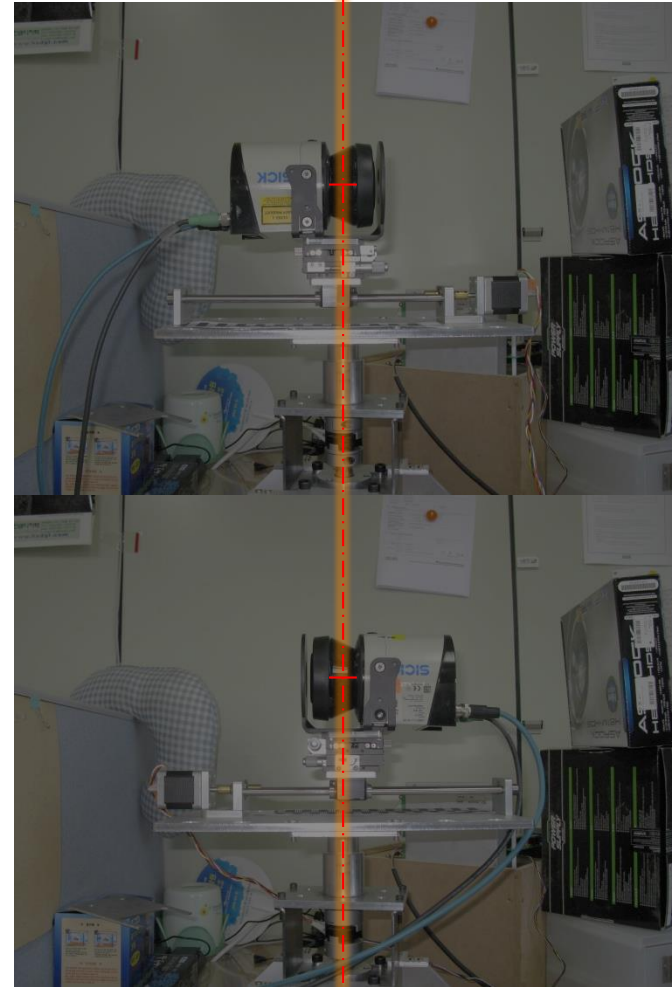
Right half rays



Left half rays

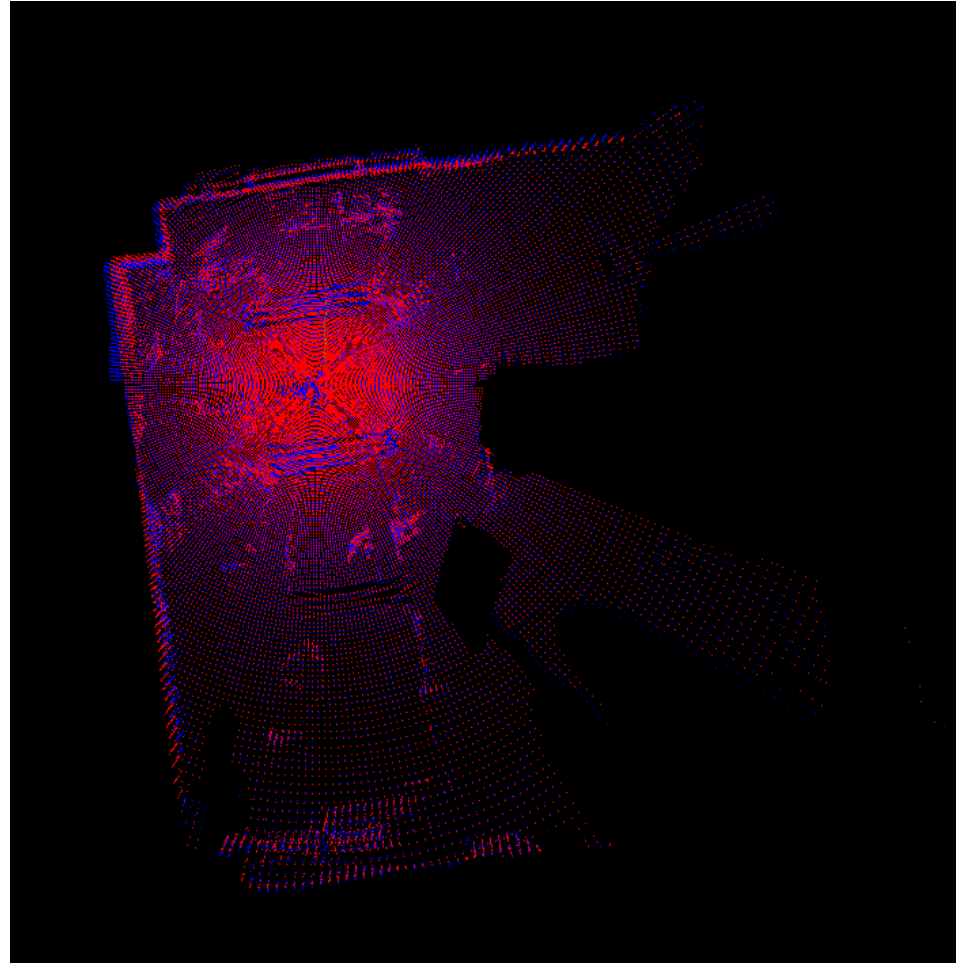


# Test result



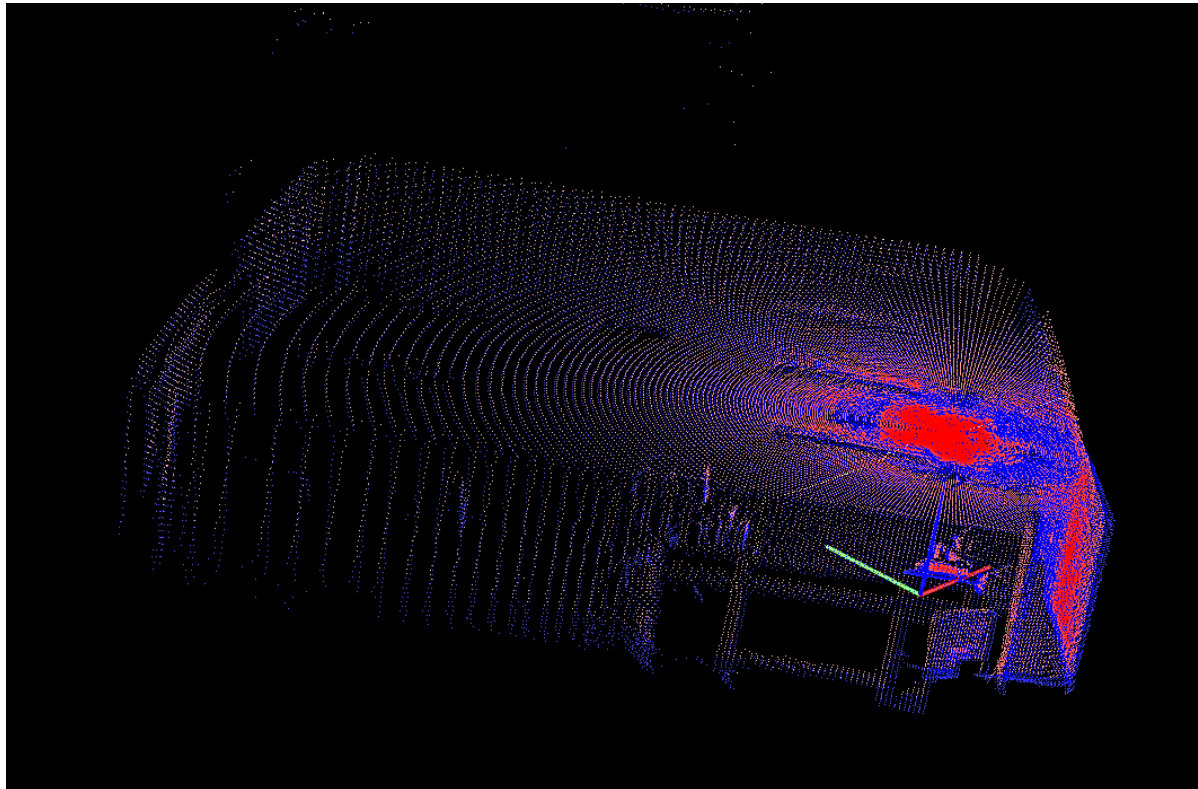
# Test result

- Ceiling view



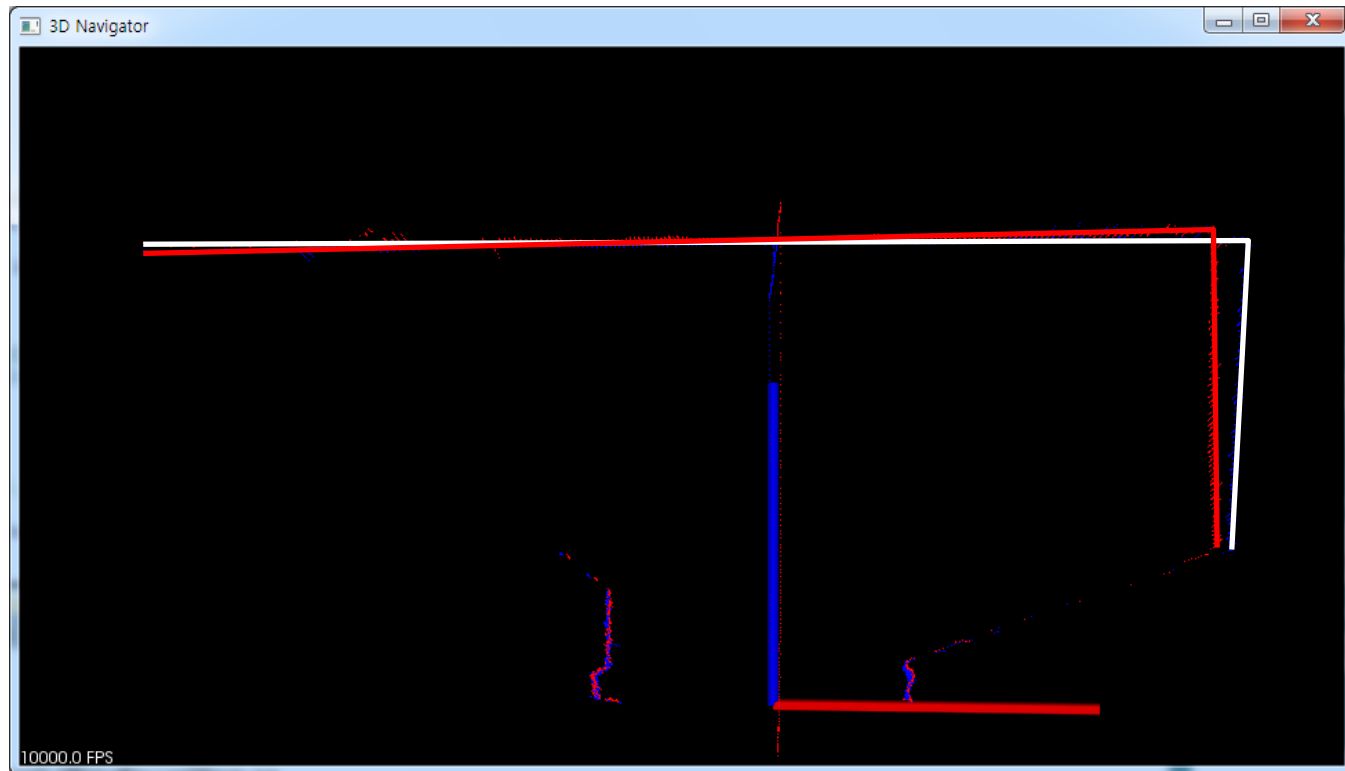
# Test result

- Bird's eye view



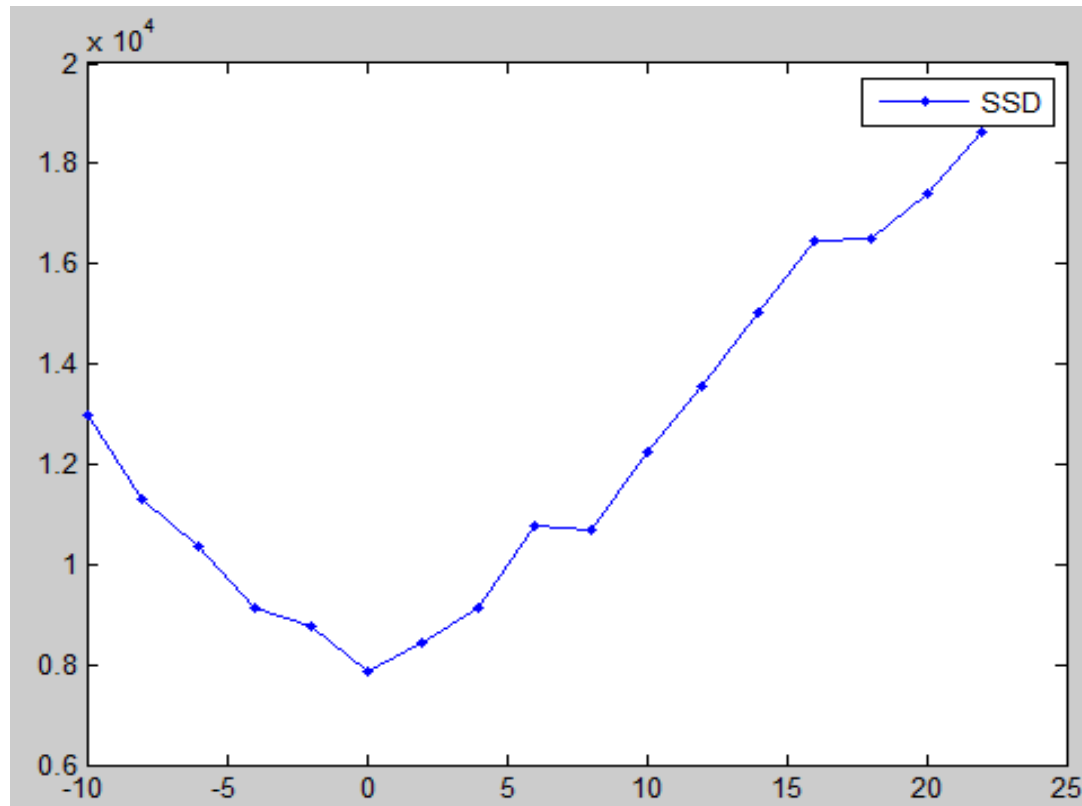
# Test result

- Hardware problem : mount is unbalanced



# Test result

- Performance evaluation



# Conclusion

- **Obtaining 3D structure of ceiling,**
  - By rotating LRF
- **The rotary calibration technique has proposed**
- **Calibration performance has been evaluated by calculating SSD of half and half rays' measurements**
- **However, the rotary calibration is not precise**
  - Because of the deflection of LRF mount